UNIVERSITY OF COLORADO AT BOULDER
18TH AND COLORADO
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1.1 SUMMARY

A. This section includes:

1. Installation of Fencing.
2. Installation of Boxing.
3. Siltation Control.
4. Protection of Trees to Remain

B. Related Work:

1. Section 01010 ‘Contractor’s Access and Staging Areas’
2. Section 01500 ‘Temporary Facilities’
3. Section 311000 ‘Site Clearing’
4. Section 312000 ‘Earth Moving’
5. Section 312333 ‘Trenching, Backfilling’
6. Section 02920 ‘Soil Preparation’
7. Section 02932 ‘Bluegrass Sodding’
8. Section 02950 ‘Trees, Plants and Groundcovers’

1.2 REFERENCES

A. ANSI Z133.1 Safety Requirements for Pruning, Trimming, Repairing, Maintaining and Removing Trees, and for Cutting Brush.


1.3 DEFINITIONS

A. Tree Protection Fencing: Temporary fencing installed prior to site preparation and demolition which protects a group of trees or shrubs.

B. Boxing: Temporary wood box form installed prior to site preparation and demolition which protects individual trees and shrubs.

C. Root Pruning: Physical cutting of plant roots to minimize root damage and promote healing.

D. Construction Branch Pruning: Physical cutting of any branch which interferes with construction.

1.4 SUBMITTALS
A. Comply with Section 01300. All submittals shall be accepted by the Landscape Architect in writing before Work commences.

B. Schedule: Submit construction schedule which includes time frame for work near existing plant material. Provide transplanting and tree removal schedule including tree transplants and locations. Obtain approval by Landscape Architect prior to beginning of transplanting work and construction near restricted area.

C. Work Methods: Submit proposed methods and schedule for effecting tree and plant protection for approval, including proposed methods, materials, and schedule for root pruning, construction pruning, aeration and subsequent tree fertilization. Mark plan location of root pruning and siltation fencing in field with paint for approval by Landscape Architect. Any root pruning which is required due to construction work adjacent to existing trees and shrubs designated to remain shall occur any time ground can be worked except when tree or shrubs are in leaf. Root pruning when tree or shrubs are in leaf may occur only with approval by Landscape Architect.

1.5 QUALITY ASSURANCE

A. Comply with Division One.

B. Qualifications

1. Arborist: Company having adequate capacity and facilities to meet the specified requirements. All tree pruning and cleaning shall be performed by a landscape contractor with a minimum 5 years documented experience. Evidence to this effect shall be provided by the supplier if required by the Architect.

C. Regulatory Requirements: City permits are necessary for pruning or removal of all trees in the right-of-way.

E. Pre-Installation Conference

1. Conduct pre-installation conference prior to construction.
2. Attendance required by: Owner, Architect, Contractor(s), Manufacturer(s),/Supplier(s), other parties who are involved.

1.6 PROJECT/SITE CONDITIONS

A. All plant materials to remain or be moved will be tagged by the Landscape Architect to assist the Contractor in identifying the trees. Contractor to notify Landscape Architect seven (7) days before tree relocation. All relocated plant material to be included in maintenance – see 1.7.

B. Maintain all plant materials within tree protection areas. Designated tree protection areas of trees, shrubs, and grasses are to remain untouched and unharmed.

C. Construction activities, including stockpiling, in tree protection areas are prohibited.

D. Tree arborist shall determine and document value of each tree or other plant materials within the limits of work line that is designated to remain. Contractor shall reimburse client for the value of any of these trees or other plant materials that are lost or damaged during construction.
1.7 MAINTENANCE

A. Maintenance Services: Performed by a landscape contractor during construction and for the first year after final completion of all site construction.

B. Maintenance Period: Begin maintenance immediately upon start of construction. Continue maintenance until one year after final completion of all site construction.

C. Maintenance to Include:

1. Quarterly review and monitoring of tree conditions.
2. Maintaining guying and lightening protection. Repair or replace when required.
3. Water at a sufficient frequency to saturate root system and keep soil moist.
4. Pruning, including removal of dead of broken branches, and treatment of pruned areas or other wounds.
5. Disease Control.

D. Protection: In accordance with paragraph 3.2 Preparation-B.

E. Root Zone Fertilization: Root zone fertilize all trees affected by construction. The first root zone fertilization shall occur within 6 months after completion of site construction and the second within 12 months. Use a liquid application with an 18 inch soil probe. Fertilization mix shall be submitted to the Landscape Architect for acceptance prior to application.

F. Pesticides: Apply pesticides, with permission of owner, in accordance with manufacturer’s instructions. Remedy damage resulting from improper use of pesticides.

G. Maintenance Reports: Provide maintenance report including date and detailed summary of work completed on site, to the Landscape Architect after each maintenance visit.

PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCING

A. Fencing: Galvanized chain link fencing, 6 ft. high.

1. Tree protection fencing is the property of the Contractor.
2. Gates at tree protection areas shall be 6'-0" width min. for maintenance vehicles and be 6'-0" ht. galvanized chain link fence.

B. Metal Fence Posts: 9 ft. galvanized steel posts, driven a minimum of 3 ft. into the ground. Space 10 ft. o.c.maxiumum.

2.2 SILTATION CONTROL FENCING

A. Fencing: 30" height. Siltation fencing complying to local codes.

B. Posts: Attach to tree protection fencing.

2.3 SOIL AMENDMENTS/MULCH


PART 3 - EXECUTION

3.1 NEW CONSTRUCTION

A. Curb cuts should not be closer than the dripline of the tree without permission from the Landscape Architect.

B. New sidewalks, paving or asphalt within the drip line of the tree must allow breathing space for tree roots. The following should be used as a guideline: For trees up to 4 inches in trunk caliper, 25 square feet of porous area is needed. For each additional 2 inches of tree caliper, 10 more square feet are needed.

C. Where grade change is required, the same area must be provided either by construction of a drywell where the level is to be raised or by building a retaining wall where the level is to be lowered. The grade within the drip line of the tree is not to be changed without Landscape Architect approval.

D. Avoid cutting surface roots wherever possible. Sidewalks and paving levels would be contoured sufficiently to avoid such cutting.

3.2 EXAMINATION

A. Verification Of Conditions: Examine areas and conditions under which the Work of this Section will be performed. Report unsatisfactory or questionable conditions to the Landscape Architect. Do not proceed with the Work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

B. Verify all utility locations in the field prior to digging.

3.3 PREPARATION

A. Marking of Construction/Demolition/Tree Preservation Limits

1. Clearly mark the tree protection fence locations as indicated on the Drawings, boxing and all construction/demolition limits in the field.
2. Mark individual tree root pruning areas and location of siltation fencing with paint.
3. Verify all trees to be removed, transplanted, or protected with Landscape Architect. Tag all plant material with appropriate tags noting action to be taken with each plant.
4. Contact and accompany Landscape Architect on a joint review of construction/demolition limits, tagging and painting before prior to the installation of the tree protection fencing and start work.
5. Verify with Landscape Architect all trees to remain along the relocated irrigation ditch.
6. Limit of construction is generally defined as the limit of demolition. Contractor to immediately notify Architect if work will occur outside the construction/demolition limits.
7. Contractor to verify limits of existing R.O.W. Contractor to obtain all necessary permits from appropriate jurisdictions prior to commencing activity within the R.O.W.

3.4 INSTALLATION OF FENCING

A. Fencing: Install tree protection fencing prior to start of demolition work and clearing and grubbing operations in accordance with the following:

1. Following approval of staking by the Landscape Architect, install fencing at the tree protection areas.
2. Install fencing as approved. No fencing is allowed within three (3) feet outside the drip line of trees.
3. Install posts 10'-0" o.c. maximum.
4. Install gates where noted on the plans.

3.5 SILTATION CONTROL

A. Fencing: Provide silt control at Tree Protection Areas by attaching silt fence to the uphill side of the protective fencing. Place lower 6" of silt fence in trench below grade. Backfill trench.

B. Drainage: Maintain positive drainage from Tree Protection Areas. Divert runoff from site around Tree Protection Areas.

3.6 ROOT PRUNING AND PROTECTION

A. Root Pruning

1. Prune roots where construction will sever roots.
2. Only clean cutting methods are acceptable. Root pruning is the physical cutting of tree roots to minimize root damage and promote healing. Unsuitable means for root pruning include trenching, vibrating plow, stump grinder. Any method which tears roots or disturbs the soil beyond the grading limit is unacceptable.
3. Hand trim roots at trench walls. Make clean cuts through roots.
4. Prune tree roots to a depth no greater than required by construction excavation, by approved means only. All roots shall be pruned by an approved method.

B. Backfill: Close trenches within 24 hours. Backfill root pruning trench with existing soil. Tamp lightly to set soil.

1. When trench closing is not possible within 24 hours, protect trench side in accordance with this Section.

C. Mulching: Apply wood mulch to a depth of 4 in. to 5 in. at minimum 10 ft. to 15 ft. radius around tree to reduce compaction and increase moisture retention. Soil shall be kept moist in root pruning areas.

D. Root Protection: If tree roots larger than two (2) inches in diameter are encountered with digging or trenching, tunnel under for any improvements if possible. Dig trench by hand only.
2. Notify Landscape Architect to allow physical inspection of excavation around root zones to determine damage and health of tree. Do not tear the roots out. Removal of two (2) inches or larger diameter roots encountered during construction is not allowed without permission of Landscape Architect.
3. Upon approval by Architect, wrap cut roots 2’ and larger with burlap to prevent scarring or excessive drying.

3.7. CONSTRUCTION BRANCH PRUNING

A. Prune any branches of trees to be preserved which interfere with construction only at the direction of the Landscape Architect. Approval of all proposed pruning is required prior to start of work. Pruning is an incidental pay item associated with the transplanting of existing trees, the planting of new trees, and the care of existing trees to remain. Payments for such incidental items shall be drawn from the project budget.

B. Remove any branches which are weak or dead.

C. Any pruning included as part of the project shall be done by a licensed tree company and in accordance with good pruning practices as approved by the Landscape Architect. Pruning shall maintain balance, form and function of tree.

3.8 TEMPORARY TREE GUYING

A. Upon review of on-site root pruning and construction grading limits, the Landscape Architect shall determine whether the existing trees designated to remain should be temporarily guyed.

B. Complete tree guying using materials and techniques designated by the Landscape Architect in accordance with Section 02900 and complete in a timely manner.

3.9 AERATION

A. If areas inside the restricted area become compacted as determined by the Landscape Architect, aerate to a 20 inch depth using an aeration "grow gun," avoiding damage to surface absorbing feeder roots.

B. Inject filler material to hold aeration fractures open.

3.10 WATERING

A. Apply supplemental watering to a depth of 10-12” (18” max) with a deep root feeder if loss of grasses or heating of the roots occurs during construction or as directed by Landscape Architect. Approximately 100 gallons per tree shall be applied.

B. Contractor to water existing trees as determined by Landscape Architect to promote healthy, thriving plant material.
C. Contractor and Landscape Architect to determine appropriate water pressure.

3.11 EXCAVATION INSULATION

A. Provide mitigation from moisture and temperature fluctuations by pinning 3 layers of burlap onto the entire face of excavations exposed for more than 24 hours.

B. Wet burlap insulation immediately following installation.

C. Keep moist for the entire period the excavation remains open.

D. Remove insulation prior to backfilling.

3.12 CHEMICALS, FERTILIZATION AND INSECT SPRAYING

A. No chemicals shall be applied or used around or near existing trees.

B. No fertilizers, insect sprays or other chemicals shall be applied before or during root or branch pruning process.

3.13 CONCRETE WASHOUT

A. Provide concrete washout in areas which drain away from the Tree Protection Areas as indicated on the Drawings. The Landscape Architect shall approve concrete washout area prior to the start of any site work.

3.14 GRADING AT TREE PROTECTION AREAS

A. All grading within protected areas shall proceed only after review and approval by the Landscape Architect.

B. All fill within protected areas must be approved by the Landscape Architect. Tamping of fill earth shall be allowed; compaction of fill earth shall not be allowed. No “cutting” of grades in root area shall be allowed.

3.15 FIELD QUALITY CONTROL/DAMAGE PENALTIES

A. Trees labeled as requiring "General Protection" or "Special Protection" adjacent to construction areas and in other key locations are identified on the Drawings. Loss of any of these trees due to Contractor neglect or improper construction activities will result in liquidated damages for the assessed value of the tree as determined by a licensed arborist. Damage to a portion of these trees will be assessed by the arborist and a portion of the liquidated damages will be assessed to the Contractor. A list of tree values for the project will be on file in the Landscape Architect's office. Any damaged tree not on this list shall be evaluated by the Architect as necessary to comply with this penalty.
B. A fine of $1,000 will be levied against the Contractor for each incident of construction (including construction traffic) inside tree protection areas.

C. Trees or roots visibly damaged will cause the Owner to withhold from the Contractor an assessed amount conforming to the requirements stipulated above, for a period of two years. After that period the impact of the damage to any tree will be assessed by the Landscape Architect.

D. If any trees or shrubs designated to be saved are damaged and replacement is required, a number and diameter of trees or shrubs of the same species and variety, as specified by the Landscape Architect, shall be furnished and planted by the Contractor. The total inch diameter of the replacement trees or shrubs shall equal the diameter of the tree or shrub to be replaced as measured by The Guide For Establishing Value of Trees and Other Plants, published by the International Society of Arboriculture. The Contractor shall not be liable for any loss or damage which occurs while the Contractor is complying with instructions given by the Landscape Architect working on the Project.

3.16 ADJUSTING

A. Tree Protection Area Access: When construction traffic is unavoidable as concurred by the Contractor and Landscape Architect the following procedure shall be followed:

1. Obtain approval from the Landscape Architect for Tree Protection Area access.
2. Install protective fencing by hand to delineate the construction corridor. Fencing location must be approved on site by the Landscape Architect.
3. Install a 12” layer of wood chips overlaid with continuous 3/4” plywood sheets on the existing grade for the entire area of the traffic route to allay rutting and slightly reduce soil compaction.
4. Remove all materials and return area to preconstruction condition within one week of the work.

B. Excavation Insulation: If in the Contractor's opinion, climate conditions do not necessitate the installation of burlap insulation at an excavation, he may submit to the Landscape Architect a written request to omit the burlap insulation. Submit request to the Landscape Architect 24 hours prior to excavation.

3.17 CLEANING

A. Removal Of Protection: Except as otherwise indicated or requested by Engineer, temporary protection devices and facilities installed during course of the work shall be removed only after all work which may injure or damage trees and plants is completed.

B. Removal: Remove all excess material during construction period and haul off-site.

C. Repair: Repair surface damage caused by fence posts. Restore to match surrounding conditions.

3.18 PROTECTION

A. Protect planting areas and plants at all times against damage of any kind for the duration of the maintenance. If any plants become damaged of injured, they shall be treated or replaced as
directed by the Landscape Architect at no additional cost to the Owner. The contractor shall not be responsible for acts of vandalism or acts of God during the maintenance period.

B. Protect tree roots in accordance with paragraph 3.7 this Section.

C. Branch Protection: Contact Landscape Architect if it appears that construction will damage to the branches of any tree. The Landscape Architect will determine action to be taken. If pruning is required, perform in accordance with paragraph 3.8 this Section.

END OF SECTION 02111
SECTION 02515 - UNIT PAVERS

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:
   1. Unit pavers.
      a. Loose laid concrete pavers.

1.2 SUBMITTALS:

A. Samples:
   1. Submit two sets of 5 units each for each type and color of paver required, showing full range of colors and textures.

B. Mock-Up:
   1. Use materials, pattern and joint treatment indicated for project work. Include special features for expansion joints and contiguous work.
   2. Mock up can be part of final product, in location indicated or directed, of full thickness and approximately 4' x 3'. Mock up can be in place.
   3. Obtain Architect's and Owner's acceptance of visual qualities of mock-up before start of unit paver work.
   4. Retain mock-up during construction as a standard for judging completed unit paver work. Do not move or destroy mock-up until work is completed.

1.3 QUALITY ASSURANCE:

A. Provide materials obtained from only one source for each type and color of pavers.

PART 2 - PRODUCTS

1.4 PAVERS:


1.5 SETTING BED SAND:

A. Sand conforming to ASTM C144 except 100% passing 0.375" sieve, 90% to 96% passing No. 4 sieve, 10% to 30% passing No. 100 sieve and not more than 3% passing No. 200 sieve.

UNIT PAVERS 02515 - 1
1.6 ACCESSORIES:

A. Paving Fabric: Dupont Typar 3401 or Celanese Mirafi 140N.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Use of paver units which are chipped, cracked, or discolored is not acceptable. Units damaged after installation shall be replaced.

3.2 LOOSE LAID INSTALLATIONS:

A. Provide paving fabric placed on smooth, prepared soil subbase with side and end joints lapped not less than 3”.

B. Provide sand setting bed for pavers. Compact sand bed by tamping or wetting and screed to 2” minimum depth or as required to allow for setting of pavers. Avoid damage to paving fabric.

C. Lay out work to minimize cutting.

D. Surface must be uniform with an even plane surface. Units with a deviation between them of more than 1/16” will be unacceptable. Units that vary more than 3/16” in vertical position when tested with a ten foot straightedge are unacceptable.

END OF SECTION 02515
SECTION 02810 - IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED - Work of this Section generally includes provisions for the installation of an underground irrigation system including the following:

A. Static pressure verification and coordination of irrigation system installation with landscape material installation.

B. Trenching, stockpiling excavation materials, refilling and compacting trenches.

C. Complete irrigation system including but not limited to piping, valves, fittings, heads, controllers and wiring, and final adjustments to insure complete coverage.

D. Water connections.

E. Replacement of unsatisfactory materials.

F. Clean-up, inspections, and approval.

G. Tests.

1.2 RELATED SECTIONS

A. Examine all sections related to project work.

1.3 REFERENCES

A. Perform Work in accordance with requirements of Conditions of the Contract and Division 01 - General requirements as well as provisions of all applicable laws, codes, ordinances, rules, and regulations.

B. Conform to requirements of reference information listed below except where more stringent requirements are shown or specified in Contract Documents.

1. American Society for Testing and Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.

2. Underwriters Laboratories (UL) - UL Wires and Cables.

1.4 QUALITY ASSURANCE

A. Installer Qualifications - Installer shall have had considerable experience and demonstrate ability in the installation of irrigation system(s) of specific type(s) in a neat orderly and responsible manner in accordance with recognized standards of workmanship. To demonstrate ability and experience necessary for this Project, and financial stability, submit if requested by Consultant, prior to contract award the following:
1. List of 3 projects completed in the last 2 years of similar complexity to this Project. Description of projects shall include:
   a. Name of project.
   b. Location.
   c. Owner.
   d. Brief description of work and project budget.

2. Current company financial statement.

B. Special Requirements:

1. Work involving substantial plumbing for installation of copper piping, backflow preventer(s), and related Work shall be executed by licensed and bonded plumber(s). Secure a permit at least 48 hours prior to start of installation.

2. Tolerances - Specified depths of mains and laterals and pitch of pipes are minimums. Settlement of trenches is cause for removal of finish grade treatment, refilling, compaction, and repair of finish grade treatment.

3. Coordination With Other Contractors - Protect, maintain, and coordinate Work with Work under other Section.

4. Damage To Other Improvements - Contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, or planting done under other Sections during Work associated with installation of irrigation system at no additional cost to Owner.

C. Pre-Construction Conference - Contractor shall schedule and conduct a conference to review in detail quality control and construction requirements for equipment, materials, and systems used to perform the Work. Conference shall be scheduled not less than 10 days prior to commencement of Work. All parties required to be in attendance shall be notified no later than 7 days prior to date of conference. Contractor shall notify qualified representatives of each party concerned with that portion of Work to attend conference, including but not limited to Architect, Consultant, Contractor's Superintendent, and Installer.

1. Minutes of conference shall be recorded and distributed by Contractor to all parties in attendance within five days of conference.

1.5 SUBMITTALS - Prepare and make submittals in accordance with conditions of the Contract.

A. Shop Drawings - Submit Shop Drawings if noted on construction drawings, include a complete materials list indicating manufacturer, model number, and description of all materials and equipment to be used. Show appropriate dimensions and adequate detail to accurately portray intent of construction.

B. Record Drawings (As-Builts):

1. At onset of irrigation installation secure mylar sepias of original irrigation design from Owner. At the end of every day, revise prints for Work accomplished that day in red ink. As-built sepias shall be brought up-to-date at the close of the working day every Friday by a qualified draftsperson. A print of record plan(s) shall be available at Project Site. Indicate zoning changes on
weekly as-built drawings. Indicate non-pressure piping changes on as-builds. Upon completion of Project, submit for review, prior to final acceptance, final set of as-built Mylar sepias. Dimensions, from two permanent points of reference (building corners, sidewalk, road intersections or permanent structures), location of following items:

2.
   a. Connection to existing water lines.
   B. Routing of sprinkler pressure lines (dimension maximum 100 feet along routing).
   c. Sprinkler control valves.
   d. Quick coupling valves.
   e. Drain valves.
   f. Control wire routing if not with pressure mainline.
   g. All gate valves.
   h. Other related equipment as directed.

3. Owners Representative will not certify any pay request submitted by the Contractor if the as-built drawings are not current, and processing of pay request will not occur until as-builts are up-dated.

C. Operation Instructions - Submit 3 written operating instructions including winterization procedures and start-up, with cut sheets of products, and coordinate controller/watering operation instruction with Owner maintenance personnel.

1. Controller Charts:
   a. Do not prepare charts until record (as-built) drawings have been reviewed by Consultant.
   b. Provide one controller chart for each automatic controller installed.
      1) Chart may be reproduction of record drawing, if scale permits fitting of controller door. If photo reduction prints are required, keep reduction to maximum size possible to retain full legibility.
      2) Chart shall be blueline print of actual "as-built" system, showing area covered by that controller.
   c. Identify area of coverage of each remote control valve, using a distinctly different pastel color drawing over entire area of coverage.
   d. Following review of charts by Consultant, they shall be hermetically sealed between two layers of 20 mm thick plastic sheet.
   e. Charts shall be completed and reviewed prior to final review of irrigation system.

1.6 DELIVERY, STORAGE, AND HANDLING - Deliver, unload, store, and handle materials, packaging, bundling, products in dry, weatherproof, condition in manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism. Deliver in original unopened packaging containers prominently displaying manufacturer's name, volume, quantity, contents, instructions, and conformance to local, state, and federal law. Remove and replace cracked, broken, or contaminated items or elements prematurely exposed to moisture, inclement weather, snow, ice, temperature extremes, fire, or jobsite damage.

A. Handling of PVC Pipe - Exercise care in handling, loading and storing, of PVC pipe. All
PVC pipe shall be transported in a vehicle which allows length of pipe to lie flat so as not to subject it to undue bending or concentrated external loads. All sections of pipe that have been dented or damaged shall be discarded, and if installed, shall be replaced with new piping.

1.7 JOBSITE CONDITIONS:

A. Protection of Property:

1. Preserve and protect all trees, plants, monuments, structures, and paved areas from damage due to Work of this Section. In the event damage does occur, all damage to inanimate items shall be completely repaired or replaced to satisfaction of Owner, and all injury to living plants shall be repaired by Owner. All costs of such repairs shall be charged to and paid by Contractor.

2. Protect buildings, walks, walls, and other property from damage. Flare and barricade open ditches. Damage caused to asphalt, concrete, or other building material surfaces shall be repaired or replaced at no cost to Owner. Restore disturbed areas to original condition.

B. Existing Trees:

1. All trenching or other Work under limb spread (dripline) of any and all evergreens or deciduous material shall be done by hand or by other methods so as to prevent damage to root system.

2. Prune any branches of trees to be preserved which may be damaged by construction.

3. Where it is necessary to excavate adjacent to existing trees use all possible care to avoid injury to trees and tree roots. Excavation, in areas where 2 inch and larger roots occur, shall be done by hand. Roots 2 inches or larger in diameter, except directly in the path of pipe of conduit, shall be tunneled under and shall be heavily wrapped with burlap to prevent scarring or excessive drying. Where a trenching machine is operated close to trees having roots smaller than 2 inches in diameter, wall of trench adjacent to tree shall be hand trimmed, making clean cuts through roots. Trenches adjacent to trees shall be closed within 24 hours, and when this is not possible, side of trench adjacent to tree shall be kept shaded with moistened burlap or canvas.

C. Protection and Repair of Underground Lines:

1. Request proper utility company to stake exact location (including depth) of all underground electric, gas, or telephone lines. Take whatever precautions are necessary to protect this underground line from damage. If damage does occur, all damage shall be repaired by Utility Owner. All costs of such repairs shall be paid by Contractor unless other arrangements have been made.

2. Request Owner, in writing, to locate all private utilities (i.e., electrical service to outside lighting) before proceeding with excavation. If, after such request and necessary staking, private utilities which were not staked are encountered and damaged by Installer, they shall be repaired by Owner at no cost to Installer. If Contractor damages staked or located utilities, they shall be repaired by Utility Owner at Contractor's expense unless other arrangements have been made.
D. Replacement of Paving and Curbs - Where trenches and lines cross existing roadways, paths, curbing, etc., damage to these shall be kept to a minimum and shall be restored to original condition.

1.8 WARRANTY/GUARANTY: - Manufacturer shall warrant materials against defects for a period of one year from date of Substantial Completion. Installer(s) shall guaranty workmanship for similar period.

A. Settling of backfilled trenches which may occur during guaranty period shall be repaired at no expense to Owner, including complete restoration of damaged property.

B. Expenses due to vandalism before substantial completion shall be borne by Contractor.

C. Owner will maintain turf and planting areas during warranty period, so as not to hamper proper operation of irrigation system.

1.9 MAINTENANCE:

A. Winterization - include cost in bid for winterizing complete system at conclusion of sprinkling season (in which system received final acceptance) within 3 days notification by the Owner. System shall be voided of water using compressed air or similar method reviewed by Consultant. Reopen, operate, and adjust system malfunctions accordingly during April of following season within 3 days of notification by Owner.

1.10 EXTRA STOCK - In addition to installed system furnish the following items to Owner:

A. 10 Pop-up spray heads with nozzles of each type used.

B. 4 Rotor heads of each type used.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. General Piping:

1. Pressure Supply Lines (downstream of backflow prevention units) - Class 200 PVC BE (1” - 2 1/2”) and Class 160 PVC RT (3” and larger).

2. Non-pressure Lines - Class 200 PVC BE.

3. PVC Sleeving - Class 160 PVC.

B. Copper Pipe and Fittings:

1. Copper Pipe - Type K, hard tempered.

2. Fittings - Wrought copper, solder joint type.

3. Joints - Soldered with solder, 45% silver, 15% copper, 16% zinc, and 24%
cadmium and solidus at 1125°F and liquids at 1145°F.

C. Brass Pipe and Fittings:

1. Brass Pipe - 85% red brass, ANSI Schedule 40 screwed pipe.
2. Fittings - Medium brass, screwed 125 pound class.

D. Plastic Pipe and Fittings:

1. Identification Markings:
   a. Identify all pipe with following indelible markings:
      1) Manufacturer's name.
      2) Nominal pipe size.
      3) Schedule of class.
      4) Pressure rating.
      5) NSF (National Sanitation Foundation) seal of approval.
      6) Date of extrusion.
   b. Solvent Weld Pipe - Manufactured from virgin polyvinyl chloride (PVC) compound in accordance with ASTM D2241 and ASTM D1784; cell classification 12454-B, Type 1, Grade 1.
      a. Fittings - Standard wright, Schedule 40, injection molder PVC; complying with ASTM D1784 and D2466, cell classification 12454-B.
         1) Threads - Injection molded type (where required).
         2) Tees and ells - Side gated.
      b. Threaded Nipples - ASTM D2464, Schedule 80 with molded threads.
      c. Joint Cement and Primer - Type as recommended by manufacturer of pipe and fittings.
   c. Gasketed End Pipe - Manufactured from virgin Polyvinyl Chloride compound in accordance with ASTM D2241 and ASTM D1784; cell classification 1254-B, Type 1, Grade 1.
      a. Fittings (3” and larger) - Ductile iron, grade 70-55-05 in accordance with ASTM A-536. Fittings shall have deep bell push-on joints with gaskets meeting ASTM F-477.
      b. Gaskets - Factory installed in pipe and fittings, having a metal or plastic support within gasket or a plastic retainer ring for gasket.
      c. Lubricant - As recommended by manufacturer of pipe fittings.

E. Gate Valves:

1. Gate Valves for 3/4 inch through 2-1/2 Inch Pipe - Brass construction; solid wedge, IPS threads, and non-rising stem with wheel operating handle.
2. Gate Valves for 3 Inch and Larger Pipe - Iron body, brass or bronze mounted AWWA gate valves with a clear waterway equal to full nominal diameter of valve; rubber gasket or mechanical joint-type only. Valves shall be able to withstand a continuous working pressure of 150 psi and be equipped with a square operating nut.

F. Quick Coupling Valves - Brass two-piece body designed for working pressure of 150 PSI; operable with quick coupler. Equip quick coupler with locking rubber cover. Key size
and type as shown on Drawing.

G. Valve Boxes:

1. Gate Valves, Drip Line Blow-out Stubs, and Wire Stub Box - Carson #910-12, Brooks #1100, box as detailed.
2. 3/4 inch through 2 inch Control Valves - Carson #1419-13B, Brooks #1419 box.
3. Drip Valve Assemblies - Carson #1320-13B as detailed.

H. Electrical Control Wiring:

1. Low Voltage:
   a. Electrical Control Wire - AWG UFUL approved No. 14 direct burial copper wire or larger, if required to operate system as designed.
   b. Wire Colors:
      1) Control Wires - Red.
      2) Common Wires - White.
      3) Master Valve Wires - Blue.
      4) Spare Control Wires - Black.
      5) Spare Common Wires - Yellow.
   c. If multiple controllers are utilized, and wire paths of different controllers cross each other, both common and control wires from each controller shall be different colors approved by Consultant.
   d. Control Wire connections and splices shall be made with 3M direct bury splice, Rain Bird Pentite connectors, or similar dry splice method.
2. High Voltage - Type required by local codes and ordinances, of proper size to accommodate needs of equipment serviced.

I. Automatic Controller - Size and type shown on Drawings; mounted as detailed.

J. Electric Control Valves - Size and type shown on Drawings having manual flow adjustment (except drip valves) and manual bleed nut.

K. Sprinkler Heads - As indicated on Drawings. Fabricated riser units in accordance with details on Drawings - with riser nipples of same size as riser opening in sprinkler body.

L. Backflow Preventer - Existing.

PART 3 - EXECUTION

3.1 LANDSCAPE PLAN REVIEW AND COORDINATION - Contractor will be held responsible for coordination between landscape and irrigation system installation. Landscape material locations shown on the Landscape Plan shall take precedence over the irrigation system equipment locations. If irrigation equipment is installed in conflict with the landscape material locations shown on the Landscape Plan, the Contractor will be required to relocate the irrigation equipment, as necessary, at Contractor’s expense.

3.2 STATIC PRESSURE VERIFICATION - Contractor shall field verify the static pressure at the project site, prior to commencing work or ordering irrigation materials, and submit findings, in
writing, to Consultant. If Contractor fails to verify static water pressure prior to commencing work or ordering irrigation materials, Contractor shall assume responsibility for all costs required to make system operational and the costs required to replace any damaged landscape material. Damage shall include all required material costs, design costs and plant replacement costs.

3.3 INSPECTION: - Examine areas and conditions under which Work of this Section is to be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.

A. Grading operations, with the exception of final grading, shall be completed and approved by Owner before staking or installation of any irrigation system begins.

3.4 PREPARATION:

A. Staking shall Occur as Follows:

1. Mark, with powdered lime, routing of pressure supply line and flag heads for first few zones. Contact Consultant 48 hours in advance and request review of staking. Consultant will advise installer as to the amount of staking to be prepared. Consultant will review staking and direct changes if required. Review does not relieve installer from coverage problems due to improper placement of heads after staking.

2. If Project has significant topography, freeform planting beds, or other amenities which could require alteration of irrigation equipment layout as deemed necessary by Consultant, do not install irrigation equipment in these areas until Consultant has reviewed equipment staking.

B. Install sleeving under asphalt paving and concrete walks, prior to concreting and paving operations, to accommodate piping and wiring. Compact backfill around sleeves to 95% Modified Proctor Density within 2% of optimum moisture content in accordance with STM D1557.

C. Trenching - Trench excavation shall follow, as much as possible, layout shown on Drawing. Dig trenches straight and support pipe continuously on bottom of trench. Trench bottom shall be clean and smooth with all rock and organic debris removed.

1. Clearances:
   a. Piping 3 Inches and Larger - Make trenches of sufficient width (14 inches minimum) to properly assemble and position pipe in trench. Minimum clearance of piping 3 inches or larger shall be 5 inches horizontally on both sides of the trench.
   b. Piping Smaller than 3 Inches - Trenches shall have a minimum width of 7 inches.
   c. Line Clearance - Provide not less than 6 inches of clearance between each line, and not less than 12 inches of clearance between lines of other trades.

2. Pipe and Wire Depth:
   a. Pressure Supply Piping - 24 inches from top of pipe.
   b. PVC Sleevings - 18 inches from top of pipe.
c. Non-pressure Piping (rotor) - 18 inches from top of pipe.
d. Non-pressure Piping (pop-up) - 12 inches from top of pipe.
e. Control Wiring - Side of pressure main.
f. Drip Tubing - 12 inches from top of pipe.
g. Emitter Tubing (Micro-tubing) - 8 inches from top of pipe.

3. Boring will be permitted only where pipe must pass under obstruction(s) which cannot be removed. In backfilling bore, final density of backfill shall match that of surrounding soil. It is acceptable to use sleeves of suitable diameter installed first by jacking or boring, and pipe laid through sleeves. Observe same precautions as though pipe were installed in open trench.

3.5 INSTALLATION - Locate other equipment as near as possible to locations designated. Deviations shall be reviewed by Consultant prior to installation.

A. PVC Piping - Snake pipe in trench as much as possible to allow for expansion and contraction. Do not install pipe when air temperature is below 40°F. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system. When pipe laying is not in progress, or at end of each day, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.

1. Solvent Weld PVC Pipe - Lay pipe and make all plastic to plastic joints in accordance with manufacturer's recommendations.

2. Gasketed End Pipes:
   a. Lay pipe and make pipe to fitting or pipe to pipe joint, following OR70 recommendations (Johns-Manville Guide for Installation of Ring-Tite Pipe), or pipe manufacturer's recommendations.
   b. Construct thrust blocks behind all gasketed fittings, tees, bends, reducers, line valves, and caps in accordance with pipe manufacturer's recommendations. Contact Consultant prior to placing thrust blocks, for observation of thrust block excavation and initial placement. Size thrust blocks based on tables below:

**THRUST BLOCK SIZING GUIDE:**
Thrust developed per 100 PSI pressure (lbs. force) for various fitting configurations.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Fitting 90 deg. Elbow</th>
<th>Fitting 45 deg. Elbow</th>
<th>Valves, Tees Dead Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1,000</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>4</td>
<td>1,800</td>
<td>1,100</td>
<td>1,300</td>
</tr>
</tbody>
</table>

Approximate bearing strength of typical soils.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Lbs/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mulch, Peat, etc.</td>
<td>0</td>
</tr>
<tr>
<td>Soft Clay</td>
<td>500</td>
</tr>
<tr>
<td>Sand</td>
<td>1,000</td>
</tr>
<tr>
<td>Sand and Gravel</td>
<td>1,500</td>
</tr>
<tr>
<td>Sand and Gravel with Clay</td>
<td>2,000</td>
</tr>
</tbody>
</table>
B. Control Wiring:

1. Low Voltage Wiring:
   a. Bury control wiring between controller and electric valves in pressure supply line trenches, strung as close as possible to main pipe lines with such wires to be consistently located below and to one side of pipe, or in separate trenches.
   b. Bundle all 24 volt wires at 10 foot intervals and lay with pressure supply line pipe to one side of the trench.
   c. Provide an expansion loop at every pressure pipe angle fitting, every electric control valve location (in valve box), and every 500 feet. Form expansion loop by wrapping wire at least 8 times around a 3/4 inch pipe and withdrawing pipe.
   d. Make all splices and E.C.V. connections using Rain Bird Pentite connectors or similar dry splice method.
   e. Install all control wire splices not occurring at control valve in a separate splice valve box.
   f. Install one control wire for each control valve.
   g. Run two spare #14 AWG UFUL control wires and one common wire from controller pedestal to the end of each and every leg of mainline. Label spare wires at controller and wire stub box.

2. High Voltage Wiring for Automatic Controller:
   a. Provide 120 volt power connection to automatic controller.
   b. All electric work shall conform to local codes, ordinances, and authorities having jurisdiction. All high voltage electrical work shall be performed by licensed electrician.

C. Automatic Controller:

1. Install controller in accordance with manufacturer's instructions as detailed and where shown on Drawings.
2. Connect remote control valves to controller in numerical sequence as shown on Drawings.
3. Final location of controller shall be approved by Consultant prior to installation.
4. Each controller shall be a dedicated separate ground wire and grounding rod as detailed.
5. All above ground conduit shall be rigid galvanized with appropriate fittings. All below ground conduit shall be schedule 40 PVC.

D. Electric Control Valves - Install cross-handle 3 inches below finished grade where shown on Drawings as detailed. When grouped together, allow at least 12 inches between valve box sides. Install each remote control valve in a separate valve box. Install individual valve box flush with grade.

E. Quick Coupling Valves - Install quick couplers on double swing-joint assemblies of Schedule 80 PVC pipe; plumb and flush to grade. Angled nipple relative to pressure
supply line shall be no more than 45 degrees and no less than 10 degrees. Install quick coupling valves as detailed.

F. Drain Valves - Install manual drain valves at all low points in pressure supply line as detailed. Provide a three cubic foot drainage sump for each drain valve installed.

G. Valve Boxes:

1. Install one valve box for each type of valve installed as detailed. Valve box extensions are not acceptable except for master valves. Install gravel sump after compaction of all trenches. Place final portion of gravel inside valve box after valve box is backfilled and compacted.

2. Brand controller letter and station number on lid of each valve box. Letter and number size shall be no smaller than 1 inch and no greater in size than 1 1/2 inches. Depth of branding shall be no more than 1/8 inch into valve box lid.

H. Gate Valves - Install where shown on Drawings as detailed.

I. Sprinkler Heads - Install sprinkler heads where designated on Drawings or where staked. Set to finish as detailed. Spacing of heads shall not exceed the maximum indicated on Drawing unless re-staked as directed by Consultant. In no case shall the spacing exceed maximum recommended by manufacturer. Install heads on double swing-joint risers of schedule 40 PVC pipe. Angled nipple relative to non-pressure line shall be no more than 45 degrees or less than 10 degrees. Adjust part circle heads for proper coverage. Adjust heads to correct height after sod is installed. Plant placement shall not interfere with intended sprinkler head coverage, piping, or other equipment. Consultant may request nozzle changes or adjustments without additional cost to the Owner.

J. Backflow Preventer - Existing.

K. Backfilling - Do not begin backfilling operations until required system tests have been completed. Backfill shall not be done in freezing weather except with review by Consultant. Leave trenches slightly mounded to allow for settlement after backfilling is completed. Trenches shall be finish graded prior to walk-through of system by Consultant.

1. Materials - Excavated material is generally considered satisfactory for backfill purposes. Backfill material shall be free of rubbish, vegetable matter, frozen materials, and stones larger than 1 inch in maximum dimension. Do not mix subsoil with topsoil. Material not suitable for backfill shall be hauled away. Contractor shall be responsible for providing suitable backfill if excavated material is unacceptable or not sufficient to meet backfill, compaction, and final grade requirements.

2. Do not leave trenches open for a period of more than 48 hours. Open excavations shall be protected in accordance with OSHA regulations.

3. Compact backfill to 90% maximum density, determined in accordance with ASTM D155-7 utilizing the following methods:
   a. Mechanical tamping.
   b. Puddling or ponding. Puddling or ponding and/or jetting is prohibited.
within 20’-0” of building or foundation walls.

L. Piping Under Paving:

1. Provide for a minimum cover of 18 inches between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete or concrete paving.
2. Piping located under areas where asphalt or concrete paving will be installed shall be bedded with sand (a layer 6” below pipe and 6” above pipe).
3. Compact backfill material in 6” lifts at 90% maximum density determined in accordance with ASTM D155-7 using manual or mechanical tamping devices.
4. Set in place, cap, and pressure test all piping under paving, in presence of Owner prior to backfilling and paving operations.
5. Piping under existing walks or concrete pavement shall be done by jacking, boring, or hydraulic driving, but where cutting or breaking of walks and/or concrete is necessary, it shall be done and replaced at no cost to Owner. Obtain permission to cut or break walks and/or concrete from Owner.

M. Water Supply and Point of Connection - Water supply shall be extended as shown from water supply lines.

3.6 FIELD QUALITY CONTROL:

A. Flushing - After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, quick coupler assemblies, and hose valves, thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for 5 minutes through furthest valves. Cap risers after flushing.

B. Testing - Conduct tests in presence of Consultant. Arrange for presence of Consultant 48 hours in advance of testing. Supply force pump and all other test equipment.

1. After backfilling, and installation of all control valves, fill pressure supply line with water, and pressurize to 40 PSI over the designated static pressure or 120 PSI, whichever is greater, for a period of 2 hours.
2. Leakage, Pressure Loss - Test is acceptable if no loss of pressure is evident during the test period.
3. Leaks - Detect and repair leaks.
4. Retest system until test pressure can be maintained for duration of test.
5. Before final acceptance, pressure supply line shall remain under pressure for a period of 48 hours.

C. Walk-Through for Substantial Completion:

1. Arrange for Consultant's presence 48 hours in advance of walk-through.
2. Entire system shall be completely installed and operational prior to scheduling of walk-through.
3. Operate each zone in its entirety for Consultant at time of walk-through and additionally, open all valve boxes if directed.
4. Generate a list of items to be corrected prior to Final Completion.
5. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.

D. Walk-Through for Final Completion:

1. Arrange for Consultant’s presence 48 hours in advance of walk-through.
2. Show evidence to Consultant that Owner has received all accessories, charts, record drawings, and equipment as required before Final Completion walk-through is scheduled.
3. Operate each zone, in its entirety for Consultant at time of walk-through to insure correction of all incomplete items.
4. Items deemed not acceptable by Consultant shall be reworked to complete satisfaction of Consultant.
5. If after request to Consultant for walk-through for Final Completion of irrigation system, Consultant finds items during walk-through which have not been properly adjusted, reworked, or replaced as indicated on list of incomplete items from previous walk-through, Contractor shall be charged for all subsequent walk-through. Funds will be withheld from final payment and/or retainage to Contractor, in amount equal to additional time and expenses required by Consultant to conduct and document further walk-throughs as deemed necessary to insure compliance with Contract Documents.

3.7 ADJUSTING - Upon completion of installation, "fine-tune" entire system by regulating valves, adjusting patterns and break-up arms, and setting pressure reducing valves at proper and similar pressure to provide optimum and efficient coverage. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible. Heads of same type shall be operating at same pressure +/- 7%.

A. If it is determined that irrigation adjustments will provide proper coverage, and improved water distribution as determined by Consultant, contractor shall make such adjustments prior to Final Acceptance, as directed, at no additional cost to Owner. Adjustments may also include changes in nozzle sizes, degrees of arc, and control valve throttling.

B. All sprinkler heads shall be set perpendicular to finish grade unless otherwise designated.

C. Areas which do not conform to designated operation requirements due to unauthorized changes or poor installation practices shall be immediately corrected at no additional cost to the Owner.

3.8 CLEANING - Maintain continuous cleaning operation throughout duration of work. Dispose of, off-site at no additional cost to Owner, all trash or debris generated by installation of irrigation system.
IRRIGATION EQUIPMENT SPECIFICATIONS  
EFFECTIVE FEBRUARY 1998

Pop-up Spray Head          Rainbird 1804-SAM-PRS
Pop-up Spray Nozzle        Rainbird 1800 Brass Nozzle
Shrub Spray Head           Rainbird 1812-SAM-PRS
Gear Driven Rotor          Hunter I-25-ADS (35 to 45 feet)
                           Hunter I-40 (Greater than 45 feet)
Control Valve              Irritol 700 Series
Controller                 Toro Network 8000 Satellite
                           Model 132-76-08
Quick Coupler Valve        Rainbird 44NP
Control Valve Boxes        Carson #1419-13B
Gate Valve Boxes           Carson #910-12
Wire Splice Boxes          Carson #910-12
Drip Valve Boxes           Carson #1320-13B
Communication Cable        Paige P7162DA
VFD Pumping Stations       Flowtronex PSI

No substitutions will be allowed for the above equipment and all equipment shall be installed according to detail sheets.

END OF SECTION 02810
SECTION 02900 - LANDSCAPING, GENERAL

PART 1 - GENERAL

1.1 SUMMARY:

A. Section includes:

1. Landscaping general requirements.
2. Landscaping accessories.

B. Related Sections:

1. Section 02111 – Tree and Plant Protection
2. Section 02810 - Irrigation System.
3. Section 02920 - Soil Preparation.
4. Section 02932 – Bluegrass Sodding
5. Section 02950 - Trees, Plants and Ground Covers.

1.2 REFERENCES:

A. Uniform Federal Accessibility Standards (UFAS).

B. University of Colorado, Boulder Campus Office of Facilities Planning:

1. Campus Master Plan.
2. Campus District Micro Master Plans (when applicable).
3. Williams Village Master Site Development Plan and Design Guidelines (when applicable).
4. Research Park Master Site Development Plan and Design Guidelines (when applicable).

1.3 DEFINITIONS:

A. The terms listed below have been used in this section and throughout the UCB Standards. Definitions are provided for each.

1. Landscape: Every single item on the campus floor except buildings occupied by people, materials storage, or equipment.
2. Operations: The series of actions taken to establish procedures and various controls that keep the campus functioning at a high level of efficiency. These include: Planning, scheduling, budgeting, coordinating, supervising, improving, and maintaining the campus landscape.
3. Maintenance: The constant and continuing upkeep of campus facilities and plant material.
4. Development: The physical evolvement of the campus landscape through the enhancement of existing facilities and the creation of new facilities where none existed before.
5. Facilities: The physical objects that are built, installed, or established that serve a
particular purpose in the campus landscape, such as buildings, walks, streets, parking lots, benches, lighting, and all other man-made items in the campus landscape -- but not plant material.

1.4 SUBMITTALS:

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Materials List:

1. Plant material including source and location.
2. Mulches; organic rocks…
3. Amendments.
4. Accessories including edging, stake-guy system.

C. Plant and Material Certifications:

1. Certificates of inspection as required by government authorities.
2. Manufacturer’s or vendor’s certified analysis for soil amendments and fertilizer materials.
3. Label data substantiating that plants, trees, shrubs and planting materials comply with specified requirements.
4. Seed vendor’s certified statement for each grass seed mixture required. Stating botanical and common name, percentages by weight, and percentages of purity, germination, and weed seed for each grass seed species.

D. Planting Schedule: Proposed planting schedule, indicating dates for each type of landscape work during normal seasons for such work in area of site. Correlate with specified maintenance periods to provide maintenance from date of substantial completion. Once accepted, revise dates only as approved in writing, after documentation of reason for delays.

E. Maintenance Instructions: Typewritten instructions recommending procedures to be established by Owner for maintenance of landscape work for one full year. Submit prior to expiration of required maintenance period(s).

1.5 QUALITY ASSURANCE:

A. Pre-Planting Inspection:

1. The Owner and Landscape Consultant will inspect all trees at the nursery before planting commences.
2. All plant fertilizers, backfill mixes, mulches and soil amendments will be accepted by the Owner prior to planting operations.

B. Planting Inspections:
1. The Owner or Landscape Consultant will inspect the staked location of all trees prior to planting.

2. The Owner or Landscape Consultant will inspect the staked locations of container stock prior to planting. Contractor to report any variance of quantity on unit price contracts.

C. Pre-Maintenance Inspection:

1. The Owner or Landscape Consultant will inspect site at the completion of all planting operations.

D. Final Inspection:

1. Final acceptance of the Owner and Landscape Consultant will not be given until all deficiencies are corrected.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packaged Material: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

1.7 JOB CONDITIONS

A. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Architect before planting.

PART 2 - MATERIALS

2.1 TOPSOIL

A. Topsoil for landscape work may not be available at site and must be furnished and as specified.

B. Provide new topsoil that is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other liter, and free of roots, stumps, stones larger than 1” inches in any direction, and other extraneous or toxic matter harmful to plant growth.

1. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at project site. Obtain topsoil only from naturally well-drained sites where topsoil occurs in depth of no less than 4 inched. Do not obtain from bogs or marshes.

2.2 SOIL AMENDMENTS AND FERTILIZERS:
A. Type, analysis and application shall be determined by the Landscape Consultant based upon type of planting and the results of specific project soil analysis.

B. Submit specific product analysis for approval.

C. Compost: A-1 organics Pro Gro II organic compost will be used for all soil treatments to provide high organic component to new soil. Alternates to be approved by the Campus Landscape Architect. Pro Gro II will be applied at a rate of 4 cu. Yds. Per 1,000 sq.ft to all sod and seed areas.

E. Mulch: Organic mulch free from deleterious materials and suitable for top dressing of trees, shrubs, or plants.

2.3 LANDSCAPE MATERIALS:

A. Bark Mulch:
   1. Western Red Cedar Mulch

B. Gravel Mulch:
   1. 3/4” crushed mountain rock, color as selected.
   2. Submit sample for acceptance. Depth shall be 3” minimum.

C. Soil Separator Fabric:
   1. 4 oz. per square yard polypropylene fabric, water permeable, and unaffected by U.V. light, freezing and thawing.
   2. Approved substitute fabrics.
   3. Provide at all barking beds and gravel beds.

D. Pre-Emergent Herbicide:
   1. Apply beneath all mulch layers and soil separator fabric. Apply at manufacturer's specified rate. Comply with EPA requirements regarding application and use of product.
   2. Submit manufacturer's data for approval.
   3. All herbicide applications will follow current university approvals and processes.

E. Landscape Edging
   2. Install per manufacturer’s instructions.

F. Crusher Fines: The following type, size, and color. Applied over specified filtration fabric.
1. Size ¼” minus
2. Color: Wyoming Red (or approved equal)
3. Applied to 3” depth

G. Anti-Desiccant: Emulsion type, film-forming agent designed to permit transpiration, but retard excessive loss of moisture from plants. Deliver in manufacturer’s fully identified containers and mix in accordance with manufacturer’s instructions.

H. Wrapping: tree-wrap tape not less than 4 inches wide, designed to prevent borer damage and winter freezing.


PART 3 - EXECUTION

3.1 PREPARATION:

A. Lay out individual tree and shrub locations and areas for multiple plantings, Stake locations and outline areas and secure Architect’s acceptance before start work. Make minor adjustments as may be required.

B. After receiving approval of staked locations, and prior to digging, the Contractor shall request and verify locations of all utilities within the planting area.
SECTION 02920 - SOIL PREPARATION

PART I - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ripping
   2. Fertilizer
   3. Soil Conditioner
   4. Fine Grading

B. Related Sections:
   1. SECTION 02810 - Irrigation Systems
   2. SECTION 02932 – Bluegrass Sodding

1.2 SUBMITTALS

A. Quality Control Submittals:
   1. Certificates: State, federal and other inspection certificates shall accompany invoice for materials showing source or origin. Submit to Owner prior to acceptance of material.

1.3 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Section 01600

B. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, bearing name and warranty of producer.

C. Notify Owner of delivery schedule in advance so material can be inspected upon arrival at project site. Immediately remove unacceptable material from project site.

1.4 PROJECT/SITE CONDITIONS

A. General: Do not perform work when climate and existing site conditions will not provide satisfactory results.

B. Vehicular accessibility on site shall be as directed by the Campus Landscape Architect. Repair damage to prepared ground and surface caused by vehicular movement during work under this section to original condition at no additional cost to the Owner. All damage incurred outside of construction limits due to vehicle or access traffic will be
repaired to the same standards listed below. Coordinate access with the University of Colorado Boulder Project Manager.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Topsoil: Remove existing top 12” of soil from site. Replace soil with 12” of new approved top soil in all proposed landscape areas including landscape beds.

B. Soil Conditioner: A-1 Organics Pro Gro II Organic Compost or approved equal to be sued for all areas requiring soil amendment. Alternates to be approved by the Campus Landscape Architect.

C. First Application Fertilizer to all landscape areas: Apply Richlawn 5-3-2 or approved equal at a rate of 1lb of Nitrogen/1000 sq. Ft. tilled to a depth of 6”

PART 3 - EXECUTION

3.1 EXAMINATION

A. General: Verify that existing site conditions are as specified and indicated before beginning work under this Section.

1. Grades: Inspect to verify rough grading is within +0.1 foot of grades indicated and specified.

2. Damaged Earth: Inspect to verify that earth rendered unfit to receive planting due to concrete, water, mortar, limewater or any other contaminant dumped on it has been removed and replaced with clean earth from a source approved by the Campus Landscape Architect.

B. Unsatisfactory Conditions: Report in writing to General Contractor with copy to Owner.

C. Acceptance: Beginning of installation means acceptance of existing conditions by installer.

3.2 PREPARATION

A. Protection:

1. Contractor shall locate sewer, water, irrigation, gas, electric, phone and other pipelines, conduits or utilities prior to commencing work.

2. Contractor shall be responsible for proper repair to landscape, utilities, walls, pavements and other existing site improvements damaged by operations under this section.

B. Weed Control: Remove weeds by removing top 12” of existing soil. Do not remove soil within tree/plant protection zones. Take care to insure that removal of soil and weeds is done in a fashion as not to contaminate surrounding soil with existing weed/weed seed.
Use of herbicide in any form must be approved in writing with the Campus Landscape Architect.

C. Surface Grade: Remove weeds, debris, clods and rocks larger than 1/2”. Dispose of accumulated debris at direction of Campus Landscape Architect.

D. Runoff: Take measures and furnish equipment and labor necessary to control the flow, drainage, and accumulation of water. Insure that all water will run off the grades.

E. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited material on the site throughout duration of work.

3.3 INSTALLATION

A. Soil Amendment:

1. Evenly distribute Pro Gro II and Richlawn 5-3-2 to landscape areas at the following rates:
   A. Pro Gro II will be applied at a rate of 4 cu. Yds. Per 1,000 sq.ft to all sod and seed areas
   B. Richlawn 5-3-2 will be applied at a rate of 1lb nitrogen/ 1000 sq.ft to all sod and seed areas

2. After applying soil conditioner and fertilizer, thoroughly till area to depth of 6” minimum by plowing, harrowing, or diskng until soil is well pulverized and thoroughly mixed.

B. Fine Grading in all Landscape Areas:

1. Do fine grading for areas prior to planting.
2. For ground surface areas surrounding buildings to be landscaped, maintain required positive drainage away from buildings.
3. Establish finish grades to within 0.04 foot of grades indicated.
   a. Sod areas: Allow 1.25” for sod.
4. Noxious weeds or parts thereof shall not be present in the surface grade prior to landscaping.
5. Prior to acceptance of grades, hand rake to smooth, even surface free of debris, clods, rocks, and vegetable matter greater than 1/2”.

3.4 NOTIFICATION AND INSPECTION

A. Inspection: Provide notice to Campus Landscape Architect requesting inspection at least 7 days prior to anticipated date of completion.

B. Deficiencies: Campus Landscape Architect will specify deficiencies to Contractor who shall make satisfactory adjustments and shall again notify Campus Landscape Architect for final inspection.

SOIL PREPARATION 02920 - 3
3.5 CLEANING

A. General: Remove debris and excess materials from site. Clean out drainage inlet structures. Clean paved and finished surfaces soiled as a result of work under this Section, in accordance with direction given by Campus Landscape Architect.

3.6 PROTECTION

A. General: Provide and install barriers as required and as directed by Campus Landscape Architect to protect completed areas against damage from pedestrian and vehicular traffic until acceptance by Owner. Contractor is not responsible for malicious destruction caused by Others.

END OF SECTION 02920
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fertilizer.
2. Sod.

B. Related Sections:

1. Section 02810 - Irrigation Systems
2. Section 02920 - Soil Preparation

1.2 REFERENCES


1.3 SUBMITTALS

A. Quality Control Submittals:

1. Certificates: State, Federal and other inspection certificates shall accompany the invoice for materials showing source or origin. Submit to Campus Landscape Architect prior to acceptance of material.

B. Contract Closeout Submittals:

1. Warranty: At completion of work, furnish written warranty to Owner based upon requirements as specified.

1.4 QUALITY ASSURANCE

A. Source Quality Control:

1. Sod Materials: Supplier must be a member of Rocky Mountain Sod Growers Association. Sod will be subject to inspection and acceptance. Campus Landscape Architect reserves the right to reject at any time or place prior to acceptance, any work and sod which in the Campus Landscape Architect's opinion fails to meet these specification requirements.

2. Inspection: Primarily for quality; however, other requirements are not waived even though visual inspection results in acceptance. Notify Campus Landscape Architect of intended sod farm prior to cutting for inspection. Inspection at growth site shall not preclude the right of rejection at project site.

3. Promptly remove rejected sod from site.
4. Inspection will be made periodically during sodding, at completion and at end of warranty period by Campus Landscape Architect.

B. Sod Standards:

1. General: Healthy, thick turf having undergone a program of regular fertilization, mowing and weed control; free of objectionable weeds; uniform in green color, leaf texture and density; healthy, vigorous root system; inspected and found free of disease, nematodes, pests and pest larvae by the entomologist of the State Department of Agriculture.

2. Each piece of Sod: Sandy-loam soil base that will not break, crumble or tear during sod installation.

3. Thickness: 1.25” thick, excluding top growth and thatch.

4. Thatch: Not to exceed 1/4” uncompressed.

5. Size: Cut in strips 18” wide no more than 24 hours prior to delivery.

6. All Sod supplied will be comprised of the same turf cultivars. Product must be cut continuously from the same turf field or from a separate field that was seeded with the same cultivars and same percentages of cultivars as original product. During all phases of grow in, establishment phase and warranty phases, color should be even after proper fertilization. Turf must be of even color without addition of specialized nutrient products. If discoloration is evident and it is believed different cultivars of sod were used, contractor bears all responsibility for providing proof that turf is of the same cultivar, including but not limited to: genetic testing done at a location of the Campus Landscape Architects choosing. All costs associated with material testing will be the responsibility of the landscape contractor. If it is determined that turf is of different cultivars landscape contractor is solely responsible for all removal and replacement costs. All repairs will be done at a time determined by the Campus Landscape Architect.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Section 01600.

B. Sod: Deliver on pallets properly loaded on vehicles and with root system protected from exposure to sun, wind, and heat in accordance with standard practice and labeled with botanical and common name of each grass species in accordance with Federal Seed Act.

1. Protect from dehydration, contamination and heating at all times. Keep stored sod moist and under shade or covered with moistened burlap.

2. Do not drop sod rolls from carts, trucks or pallets.

3. Do not deliver more sod than can be installed within 24 hours.

4. Do not stack sod more than 2 feet deep.

C. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark, warranty and conformance to state law.

1. Material shall be inspected upon arrival at job site.
2. Immediately remove unacceptable material from job site.

1.6 PROJECT/SITE CONDITIONS

A. Existing Conditions:

1. Import and place any fill material required to adjust the fine grade to meet drainage requirements or to match hard surface fine grades.

2. Vehicular accessibility on site shall be as directed by Campus Landscape Architect. Repair damage to prepared grounds and surfaces caused by vehicular movement during work under this section to original condition at no additional cost to Owner.

B. Environmental Requirements:

1. Bluegrass sodding or landscape may be installed between the dates of April 1 - October 1. Variation from these dates requires written authorization from Campus Landscape Architect, and may require extended warranty.

2. Do not install sod on saturated or frozen soil.

1.7 WARRANTY

A. Sod: Warrant sod for a period of one year from date of Substantial Completion be in a healthy, vigorous growing condition.

1. During the original warranty period, replace at once sod areas that die due to natural causes, etc., or which in Campus Landscape Architect's opinions are unhealthy.

2. Replacement will not be required in any season definitely unfavorable for sodding.

3. Install replacements as originally specified and warranted.

1.8 MAINTENANCE

A. General: The maintenance period shall begin immediately after each area is sodded and continue until final acceptance of entire project. During this time, be responsible for watering, mowing, spraying, weeding, aerating, fertilizing, and all related work as necessary to ensure that sodded areas are in a vigorous growing condition. Furnish all supervision, labor, material and equipment to maintain turf areas.

B. Materials: Conform to specification or otherwise be acceptable to Owner.

C. Watering: Water sod sufficiently to moisten subsoil in a manner not to cause erosion, damage, or overwater to a point which firmness of subsoil is compromised must prevent
excessive water usage during initial watering to prevent any changes to the grade of the install. Water shall be free of substances harmful to plant growth. Be responsible for furnishing water from underground sprinkler system, quick couplers or other source.

D. Fertilizing: If work has not received final acceptance within 45 days after initial fertilizer application to sodded areas, repeat fertilizer application to maintain optimal sod vigor.

E. Mowing and Trimming:
   1. Mow and Trim around trees (keeping mulch in saucers and beds), walls, fences, etc., maintaining turf at 2½-2 3/4" height. Do not remove more than 33% of grass leaf in single mowing. Remove grass clippings from pavement areas.

F. Resodding: Resod spots larger than 1 sq. ft. not having healthy, uniform stand of grass.

G. Weed Control: As required, using selective herbicides approved by Owner, following current university policies.

H. Insect and Disease Control: As required, using insecticides and fungicides approved by Owner, following current university policies.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Sod: Sod to be provided by a member of the Rocky Mountain Sod Growers Association and have an average N.T.E.P test result of 6.0 or higher in the Color, Vigor, and Density class. The mix should have at least three cultivars of Kentucky bluegrass each with the same N.T.E.P scores as stated above. Submit proposed blend to the Campus Landscape Architect for review and approval prior to application.

B. Water: Free of substances harmful to plant growth. Be responsible for furnishing water from underground sprinkler system, quick couplers or other source.

C. Fertilizer: Inorganic mixture with following chemical composition:
   1. First Application: Under Section 02920, 2.01 C.

PART 3 - EXECUTION

3.1 EXAMINATION

A. General - Verify that existing site conditions are as specified and indicated before beginning work under this section.
   1. Layout: Verify layout of sodded areas as indicated prior to starting operations.
   2. Grades: Verify that grades are within 0.04 ft. of grades indicated and specified.
B. Unsatisfactory Conditions: Report in writing to General Contractor with copy to Campus Landscape Architect.

C. Beginning of installation means acceptance of existing conditions by this Contractor.

3.2 PREPARATION

A. Protection:
   1. Pay for repairs made by contractors designated by Owner & Campus Landscape Architect.
   2. Identify prepared sod areas requiring protection and erect barriers for proper protection and traffic control.
   3. All areas related to the project are subject to landscape repairs including areas outside of the construction work limit fencing including but not limited to: landscape damage from irrigation shut downs required by the project in areas outside limits of construction fence, all damage related to traffic pattern changes that are caused by fencing or construction operation and other damage caused by the contractor or subcontractors will be the responsibility of the contractor.

B. Sodding Areas: Remove weeds, debris and rocks larger than 1/4" which may hinder sodding. Dispose of accumulated debris off site while taking care to prevent weed seed contamination during removal.

C. Adjustment: Adjust irrigation heads to proper watering height according to depth of sod material but lower than compacted blade height to enable lawn mowers to cut grass freely without damage to the sprinkler system.

D. Fine Grading: Perform as required to maintain positive drainage, prevent ponding and direct run-off into catch basins, drainage structures, etc., and as required to provide smooth well-contoured surface prior to proceeding. Tolerance: ± 0.04 foot. All areas will be inspected by Campus Landscape Architect prior to installation of sod.

3.3 FERTILIZING

A. First Application to newly sodded areas: Under Section 02920 2.1C.

3.4 SODDING

A. Sodding:
   1. Soil on which sod is laid: Slightly moist.
   2. Lay with longest dimension parallel to contours and in continuous rows.
   3. Tightly butt ends and sides of sod together. Stagger and compact vertical joints between sod strips by rolling so sod will be incorporated with the ground surface,
insuring tight joints between adjacent pieces.

B. Rolling: When soil and sod are moist, roll sod lightly as soon as possible after it is laid. Delay rolling until just before the second watering.

C. Topsoil: Add along exposed edges to match adjacent grade. Feather topsoil out approximately 2 ft. from edge of sod. Transition to existing sod will be smooth.

D. Drainage: Assure finished areas of sod are such that positive drainage of storm and irrigation water will occur and ponding of water will be minimized.

3.5 REPAIR OF EXISTING SOD AREAS DISTURBED BY RENOVATION

A. Repair existing sod areas disturbed by renovation work (utilities, paving, etc.), as indicated, in accordance with specifications of this section.

3.6 NOTIFICATION OF INSPECTION

A. Notification: Give notice requesting inspection by Campus Landscape Architect at least 7 days prior to the anticipated date of completion. All sod must be alive and healthy in order to be considered complete.

B. Deficiencies: If deficiencies exist, Campus Landscape Architect shall specify such deficiencies to the Contractor who shall make satisfactory adjustments and will again notify the Campus Landscape Architect for final inspection.

3.7 CLEANING

A. Cleaning: Remove pallets, unused sod, and other debris from site. Clean paved and finished surfaces soiled as a result of work under this Section in accordance with directions given by Campus Landscape Architect. Clean out drainage inlet structures.

3.8 PROTECTION

A. General: Provide and install barriers as required and as directed by Campus Landscape Architect to protect sodded areas against damage from pedestrian and vehicular traffic until acceptance by Owner. Contractor is not responsible for malicious destruction of sodding caused by others.

END OF SECTION 02932
SECTION 02950 - TREES, PLANTS AND GROUND COVERS

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Trees.
2. Plants and shrubs.
4. Non-plant materials required to complete installation of planting.

B. Related Sections:

1. Section 02810 - Irrigation Systems.
2. Section 02900 - Landscaping, General.
3. Section 02920 - Soil Preparation.

1.2 REFERENCES:

A. Standards:

1. Plants shall be first-class representatives of the specified species or variety, in healthy condition with normal well-developed branch and root systems, free of objectionable features, and shall conform to requirements as follows:

   a. USDA Standards for Nursery Stock.
   b. AAN Standardized Specifications.
   c. American Joint Committee on Horticulture (AJCH) (plant names shall meet standards of AJCH).

1.3 SUBMITTALS:

A. Certificates of Inspection for Materials:

1. State, Federal, or other inspection certificates shall accompany invoice for materials showing source or origin.
B. Plant List:

1. Submit list of plants. Refer to Section 01300;
2. Indicate which plants have special watering requirements.

C. Maintenance Instructions:

1. At completion of work, furnish three copies of written maintenance instructions to Owner for maintenance and care of installed plants through a full growing season.
2. Maintenance shall be the responsibility of Landscaping Subcontractor for 1 year after final acceptance of project.
3. The Owner shall be notified 14 days in advance of the date that maintenance operations will be discontinued.

1.4 QUALITY ASSURANCE:

A. Inspection and Approval: The Owner reserves the right to reject, at any time or place prior to final acceptance, of the installation, any materials and plants which in the Owner's opinion fails to meet specified standards requirements.

B. Inspection of plants is primarily for quality; size and variety, however, other requirements are not waived even though visual inspection results in approval.

C. Plants may be inspected where growing, but inspection at place of growth shall not preclude the right of rejection at site.

D. Rejected plants and other materials will be promptly removed from site.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Fertilizer:

1. Deliver to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to Local, State and Federal law.

B. Protection:

1. Plants shall be containerized with limbs bound, properly pruned and prepared for shipping.
2. Root system shall be kept moist and plants shall be protected from adverse conditions.
C. Identification:

1. Each plant shall be identified by means of grower's label affixed to plant.
2. Grower's label will give data necessary to indicate conformance to specifications.
3. Use durable waterproof labels with water resistant ink which will remain legible for at least 60 days.

1.6 SITE CONDITIONS:

A. Repair of lawn watering system, other underground pipe, electrical wiring, concrete walkways, sodded areas or other appurtenances damaged by operations under this Section at no additional cost to the Owner.

1.7 PLANT WARRANTY:

A. For a period of one (1) full growing season after Final Acceptance of Landscape work and at no additional cost to the Owner, the Contractor shall replace any trees, shrubs or ground cover that are dead, or that are, in the opinion of the Owner, in un-healthy, or unsightly condition, or that have lost their natural shape due to dead branches or excessive pruning of dead branches.

B. Replacement of planting shall be in accordance with the original specifications and its cost shall be included.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL:

A. Plant List:

1. Refer to "Schedule" provided in construction drawings.

LEED WEc1: Water Efficient Landscaping
When feasible, plants chosen from schedule shall be native and adapted to local climate conditions.

B. Size:

1. Minimum acceptable sizes of plants measured before pruning with branches in normal position.

C. Source:

1. Hardiness Zones:
a. Shrubs grown in Hardiness Zones 2, 3, 4 and 5 only will be accepted. Hardiness Zones are defined in U.S. Department of Agriculture publications.

2. Nursery Grown:

a. Plants shall be nursery grown. The term "nursery grown" will include gathered native plants and imported plants that have been growing in a nursery for a minimum of one growing season.

2.2 BACKFILL MATERIAL:

A. Planting mix shall be existing topsoils blended 50%/50% with A1 Premium 3 Organic Compost.

B. Topsoils:

1. Use topsoils stockpiled on site, free from toxic substances, sticks, debris, vegetation and stones over 1" (2.5cm) in maximum dimension.

2. In the event that no suitable topsoil exists after site clearing, the Contractor shall provide adequate topsoil at no additional cost.

3. The Design Consultant shall specify suitable import topsoil material.

2.3 TREE WRAPPING MATERIALS:

A. Will be first quality 4" wide Bituminous impregnated tape, corrugated or crepe paper, brown in color, specifically manufactured for tree wrapping and having qualities to resist insect infestation.

2.4 STAKING AND GUYING MATERIAL:

A. Stakes will be standard wood 8' high stakes.

B. Protective loops will be nylon, of a composition durable enough to last two years.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Positioning:
1. Shrubs and trees will be placed in position prior to planting, for final acceptance to location by the Owner or Landscape Consultant.

B. Placing Plants:

1. Planting will be done in accord with good horticultural practice or region. Trees should be planted so the top of the root ball is at least one (1) inch above surrounding grade.

C. Excavation of Planting Pit:

1. After preparation of soil, the plant pit, centered on the location stake, shall be excavated in a cylindrical shape with vertical sides and flat or saucer-shaped bottom. Sides of the plant pit shall be scarified. Diameter of plant pit will be at least twice the spread of ball or container.

D. Root Care:

1. Do not remove protective wrapping of root ball or bare roots until plant is positioned accurately in planting pit. When positioned, remove wire mesh and burlap prior to backfilling.
2. Score root balls of containerized shrubs just prior to planting.

E. Pruning and Watering:

1. Plant material will be pruned only to remove dead, injured or lower branches.

LEED WEc1: Water Efficient Landscaping

Plant material specified shall be chosen to minimize water consumption for irrigation.

F. Guying and Staking:

1. Guy and stake in accordance with the standard detail following this section.

G. Tree Mulch Ring:

1. Provide an eight (8) foot diameter mulch ring around each newly planted tree.

3.2 PRE-EMERGENT HERBICIDE:

A. Will be applied as per manufacturer's specification, at Owner’s approval
3.3 MULCHING:

A. Organic Mulch:

1. Mulch planting saucers, beds, tree mulch ring and areas within two days after planting.

3.4 PRUNING:

A. New Plant Material:

1. Prune minimum necessary to remove injured twigs and branches, deadwood and suckers.

3.5 PLANT MAINTENANCE AND ACCEPTANCE:

A. Maintenance period will begin immediately after plant material is installed until final acceptance of landscape work.

B. Maintenance shall include watering, weeding, cultivating, mulching removal of dead branches, restoring plants to proper grade or upright position and other necessary operations.

3.6 SCHEDULE:

A. Climatological factors directly influence and limit in many ways the possible choices available to the designers of Boulder Campus landscaping.

END OF SECTION 02950
SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. All drawings associated with the entire project, including general provisions of the Contract, including The General Conditions of the Contract for Construction, General and Supplementary Conditions specification sections shall apply to the Division 23 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with the aforementioned and all other Contract Documents associated with the project.

B. Related Sections: Refer to all sections in Division 23. Refer to Division 26 specification sections and Division 26 drawings.

C. Contractor shall be defined as any and all entities involved with the construction of the project.

1.2 SUMMARY:

A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 23.

1.3 MECHANICAL INSTALLATIONS:

A. The Contract Documents are diagrammatic, showing certain physical relationships which must be established within the mechanical work and its interface with all other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.

B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.

C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, Contractor shall take the necessary measurements and prepare the drawings.

D. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.

E. The contract documents indicate required size and points of terminations of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. It is not intended that drawings indicate necessary offsets. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.

F. Before any work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as intended without interferences between systems, structural elements or work of other trades.

G. Verify all dimensions by field measurements.
H. Coordinate installation in chases, slots and openings with all other building components to allow for proper mechanical installations.

I. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

J. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

K. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

L. Make allowance for expansion and contraction for all building components and piping systems that are subject to such.

M. The Contractor shall provide all labor and material necessary but not limited to the starting/stopping of all mechanical equipment, opening/closing of all valves, draining/refilling all mechanical systems and operating/verifying the operation of all mechanical systems controls as required to accomplish all work necessary to meet construction document requirements. Contractor shall submit records of such activities to engineer and include in the O & M manuals.

1.4 COORDINATION:

A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for preparing coordination drawings, showing all work, in all areas. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, isolation valves, offsets, hangers, control devices, etc., necessary to overcome congested conditions at no increase in contract sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.

B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project.

C. Existing Conditions:
   1. Carefully survey existing conditions prior to bidding work.
   2. Provide proper coordination of mechanical work with existing conditions.
   3. Report any issues or conflicts immediately to Engineer before commencing with work and prior to purchasing equipment and materials.

D. Utility Connections:
   1. Coordinate mechanical utility interruptions one week in advance with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

1.5 COORDINATION WITH OTHER DIVISIONS:

A. General:
   1. Coordinate all work to conform with the progress of the work of other trades.
2. Complete the entire installation as soon as the condition of the building will permit. No extras will be allowed for corrections of ill timed work, when such corrections are required for proper installation of other work.

B. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other sections of the specifications can be built at the proper time.

C. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

D. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Refer to Division 1 and Division 23.

E. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attentions to changes required in other work as result of modifications shall be paid for by responsible Contractor/Subcontractor.

F. Coordination with Electrical Work: Refer to Division 1 and 26.

1.6 DESIGN WORK REQUIRED BY CONTRACTOR:

A. The construction of this project requires the Contractor to include the detailing and design of several systems and/or subsystems. All such design work associated with the development of the coordination drawings shall be the complete responsibility of the Contractor.

B. The Contractor shall take the full responsibility to develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers contract drawings shall be for system design intent and general configurations.

C. Systems or subsystems which require design responsibility by the contractor include but are not limited to:

1. Any system not fully detailed
2. Equipment supports, hangers, anchors and seismic systems not fully detailed nor specified in these documents, or catalogued by the manufacturer.

D. Design Limitations:

1. The Contractor shall not modify the Engineers design intent in any way.
2. The Contractor shall not change any pipe size or equipment size without prior written approval from the Engineer.
3. Bull nosed tees on piping systems shall not be installed under any circumstance.

1.7 PROJECT CONDITIONS:

A. The Contractor shall be required to attend a mandatory pre-bid walk-thru and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.

B. Field verify all conditions prior to submitting bids.

C. Report any damaged equipment or systems to the Owner prior to any work.
D. Protect all mechanical and electrical work against theft, injury or damage from all causes until it has been tested and accepted.

E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

F. The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections, system shutdowns and start-ups, flushing and filling both new and existing systems.

G. Provide temporary ductwork and piping services, where required, to maintain existing areas operable.

H. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, one week in advance.

I. Minimize disruptions to operation of mechanical systems in occupied areas.

1.8 SAFETY:

A. Contractor shall develop and submit to Owner a detailed safety plan for all work within the tunnel. Submit confined space certification cards and calibration of air monitors.

1.9 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:

A. Refer to Division 1 and conform with the Owners requirements.

1.10 REQUIREMENTS OF REGULATORY AGENCIES:

A. Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, SMACNA, EPA, OSHA and ASHRAE.

B. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

C. The handling, removal and disposal of regulated refrigerants shall be in accordance with U.S. EPA, state and local regulations.

D. The handling, removal and disposal of lead based paint and other lead containing materials shall comply with EPA, OSHA, and any other Federal, State, or local regulations.

E. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

1.11 PERMITS AND FEES:

A. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.
1.12 PROJECT SEISMIC REQUIREMENTS:

A. All systems shall be installed to meet NFPA and IBC Seismic requirements.
   1. Where any conflicts arise the more stringent requirements shall be applicable.
   2. The design of the seismic requirements shall be the full responsibility of the Contractor.

1.13 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. Materials and equipment of equivalent quality may be submitted for substituted prior to bidding. This may be done by submitting to the at least ten (10) working days prior to the bid date a letter in triplicate requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.
   1. Substitutions shall be allowed only upon the written approval of the Engineer NO EXCEPTIONS.
   2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications or which does not have prior approval.

1.14 MECHANICAL SUBMITTALS:

A. General
   1. Refer to the Conditions of the Contract (General and Supplementary), Division 1.
   2. The submittals shall be submitted as one package identified by the specification section. Submittals that are not complete with the required information will be sent back to be corrected.
   3. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.
   4. At least one copy of the first submittal package shall be provided in expandable, 3 post, hard back binders, sized to fit all future submittals for this job. The cover shall be identified with the job name, Owner's project number, date, Prime Contractor's name, etc.
   5. Submittals may be provided electronically. All electronic submittals need to be complete with all design information and stamped for conformity by the contractor. Any submittal not stamped or complete will be sent back. Submittals that are submitted electronically will be reviewed, marked appropriately and returned by the same means received.
   6. An index shall be provided which includes:
      a. Product
      b. Plan Code (if applicable)
      c. Specification Section
      d. Manufacturer and Model Number

B. The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.
C. All equipment shall conform to the State and/or local Energy Conservation Standards.

D. Submittal of shop drawings, product data and samples will be accepted only when submitted by and stamped by the General Contractor. Data submitted from Subcontractors and material suppliers directly to the Engineer will not be processed unless prior written approval is obtained by the General Contractor.

E. Before starting work, prepare and submit to the Architect/Engineer six (6) sets of all shop drawings and descriptive equipment data required for the project. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned “Revise and Resubmit”. Where an entire submittal package is returned for action by the Contractor, the Engineer will summarize comments in letter format and return the entire set. Continue to submit six (6) sets of any individual shop drawings, product data or samples which were returned without a “make corrections noted” or “no exceptions taken” action, until they are so marked. When a “Make Corrections Noted” is received, make the required corrections for inclusion in the operation and maintenance manual. Submittals marked “Make Corrections Noted” shall not be resubmitted during the submittal process.

F. The Design Professional’s review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:

1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
2. Construction means or methods
3. Coordination of the work with other trades
4. Construction safety precautions

G. The Design Professional’s review shall be conducted with reasonable promptness while allowing sufficient time in the Design Professional’s judgment to permit adequate review. Review of a specific item shall not indicate that the Design Professional has reviewed the entire assembly of which the item is a component.

H. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.

I. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.

1.15 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:

A. Product Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.

2. Delete or mark-out portions of pre-printed data which are not applicable.

3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:
   a. Sizes.
   b. Weights.
   c. Speeds.
   d. Capacities.
   e. Piping and electrical connection sizes and locations.
   f. Statements of compliance with the required standards and regulations.
   g. Performance data.
   h. Manufacturer’s specifications.

B. Shop Drawings:
   1. Shop Drawings are defined as mechanical system layout drawings prepared specifically for this project, or fabrication and assembly type drawings of system components to show more detail than typical pre-printed materials.
   2. Prepare Mechanical Shop Drawings, except diagrams, to accurate scale, min 1/8"-1'-0", unless otherwise noted.
      a. Show clearance dimensions at critical locations.
      b. Show dimensions of spaces required for operation and maintenance.
      c. Show interfaces with other work, including structural support.

C. Test Reports:
   1. Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test.
   2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.
   3. Submit test reports as required for O & M manuals.

D. Product Listing:
   1. Prepare listing of major mechanical equipment and materials for the project, within (2) two weeks of signing the Contract Documents and transmit to the Architect. A sample schedule is included at the end of this section to complete this requirement.
      a. Provide all information requested.
      b. Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION."
   2. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.
   3. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units and similar items used in work, except as otherwise indicated.
a. Provide products which are compatible within systems and other connected items.

E. Schedule of Values

1. Provide preliminary schedule of values with product data submittal, within three (3) weeks from award of contract to successful bidder. Provide according to the following descriptions:
   a. Plumbing
   b. HVAC
      1) Equipment
      2) Piping
      3) Insulation
      4) Test and Balancing
      5) Specialty Systems
   c. Demolition
   d. Miscellaneous

2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.

F. Coordination Drawings: See section 1.4 of this specification section.

G. Required Submittals: Provide submittals for each item of equipment specified or scheduled in the contract documents. See table at the end of this section.

H. If more than two submittals (either for product data, shop drawings, record drawings, or test and balance reports) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

1.16 DELIVERY, STORAGE, AND HANDLING:

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged and protected to prevent damage or contamination during shipment, storage, and handling.

B. Check delivered equipment against contract documents and submittals.

C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust, freezing, heat and moisture.

D. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

E. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

F. Protect stored ductwork, pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.
G. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or be packaging with durable, waterproof wrapping.

H. Protect sheet metal ductwork and fittings. Elevate and store above grade and cover ends with waterproof wrapping.

1.17 DEMOLITION:

A. During the demolition phase of this contract it is the responsibility of this Contractor to carefully remove existing equipment, piping or ductwork and related items either as shown on the demolition drawings as being removed, or as required for the work. These items shall be tagged, protected from damage and stored as directed by the Architect. A list of all items stored shall be turned over to the Architect. At the completion of the remodeling work or when directed by the Architect, all stored items not reused or wanted by the Owner shall be removed from the premises. Disposition of items not reused is by the direction of the Engineer.

B. The location of existing equipment, pipes, ductwork, etc., shown on the drawings has been taken from existing drawings and is, therefore, only as accurate as that information. All existing conditions shall be verified from field measurements with necessary adjustment being made to the drawing information.

C. If asbestos material, in any form, is discovered by this Contractor in the process of his work, he shall report such occurrence to the Owner immediately. The Owner will determine the action to be taken for the asbestos removal, which is not a part of the work to be done under this Division.

1.18 CUTTING AND PATCHING:

A. This Article specifies the cutting and patching of mechanical equipment, components and materials to include removal and legal disposal of selected materials, components and equipment.

B. Do not endanger or damage installed work through procedures and processes of cutting and patching.

C. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.

D. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective or non-conforming installations.

E. Perform cutting, fitting and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work;
2. Remove and replace defective work;
3. Remove and replace work not conforming to requirements of the Contract Documents;
4. Remove samples of installed work as specified for testing;
5. Install equipment and materials in existing structures;
6. Upon written instructions from the Engineer, uncover and restore work to provide for Engineer observation of concealed work.

F. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim and other mechanical items made obsolete by the new work.
G. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.

H. Provide and maintain an approved type of temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas. Temporary partitions must not impede access to building egress.

I. Locate, identify, and protect mechanical and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover. Cover openings in ductwork to remain. Protect equipment and systems to remain.

1.19 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.

C. Work through all coordination before rough-in begins.

1.20 ACCESSIBILITY:

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

1.21 CLEANING:

A. Refer to Division 23, "TESTING, ADJUSTING AND BALANCING" for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

1.22 EXCAVATING AND BACKFILLING:

A. General:

1. Provide all necessary excavation and backfill for installation of mechanical work.

2. In general, follow all regulations of OSHA as specified in Part 1926, Subpart P, "Excavations, Trenching and Shoring." Follow specifications of Division 23 as they refer specifically to the mechanical work.

B. Contact Owners of all underground utilities to have them located and marked, at least 2 business days before excavation is to begin. Also, prior to starting excavation brief employees on marking and color codes and train employees on excavation and safety procedures for natural gas lines. When excavation approaches gas lines, expose lines by carefully probing and hand digging.

C. Provide all necessary pumping, cribbing and shoring.
D. Walls of all trenches shall be a minimum of 6 inches clearance from the side of the nearest mechanical work. Install pipes with a minimum of 6 inches clearance between them when located in same trench.

E. Pipe Trenching:
   1. Dig trenches to depth, width, configuration, and grade appropriate to the piping being installed. Dig trenches to 6 inches below the level of the bottom of the pipe to be installed. Install 6 inches bed of pea gravel or squeegee, mechanically tamp to provide a firm bed for piping, true to line and grade without irregularity. Provide depressions only at hubs, couplings, flanges, or other normal pipe protrusions.

F. Backfilling shall not be started until all work has been inspected, tested and accepted. All backfill material shall be reviewed by the engineer. In no case shall lumber, metal or other debris be buried in with backfill.
   1. Provide warning tape for marking and locating underground utilities. Tape shall be specifically manufactured for this purpose and shall be polyethylene film, 6 inches wide, 0.004 inches thick and have a minimum strength of 1750 psi. Tape shall carry continuous inscription naming the specific utility.
      a. Tape shall have magnetic strip and be used for exterior underground system only.

G. Trench Backfill:
   1. Backfill to 12 inches above top of piping with pea gravel or squeegee, the same as used for piping bed, compact properly.
   2. Continue backfill to finish grade, using flowable fill per the UCB Standards Section 02221.

H. After backfilling and compacting, any settling shall be refilled, tamped, and refinished at this contractor's expense.

I. This contractor shall repair and pay for any damage to finished surfaces.

J. Complete the backfilling near manholes using pea gravel or squeegee, installing it in 6 inch lifts and mechanically tamping to achieve 95 percent compaction.

1.23 RECORD DOCUMENTS:
A. Keep a complete set of record document prints in custody during entire period of construction at the construction site. Documents shall be updated on a weekly basis.

B. Mark Drawing Prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverted and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping or ductwork relocated more than 1 foot-0 inches from where shown on the drawings.
C. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.

D. Mark equipment and fixture schedules on drawings to indicate manufacturer and model numbers of installed equipment and fixtures.

E. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme:
   1. Red shall indicate new items, deviations and routing.
   2. Green shall indicate items removed or deleted.
   3. Blue shall be used for relevant notes and descriptions.

F. At the completion of the project, obtain from the Engineer a complete set of the Mechanical Contract Documents in a read-only electronic format (.pdf unless otherwise noted). This set will include all revisions officially documented through the Architect/Engineer. Plot these drawings and using the above color scheme, transfer any undocumented revisions from the construction site record drawings to this complete set. Submit original hardcopies of both sets of marked up documents to the Architect/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Architect/Engineer.

G. At the completion of the project, obtain from the Architect a complete set of the Mechanical Construction Documents in the electronic format used by the design team. This set will include all revisions officially issued through the Architect. The Contractor shall transfer all revisions noted on the record document prints to the electronic drawings. The Contractor shall transmit the final record documents in the electronic format used on the project to the Architect. This contract will not be considered completed until these record drawings have been received and reviewed by the Architect/Engineer.

1.24 OPERATION AND MAINTENANCE DATA:

A. No later than four (4) weeks prior to the completion of the project, make up minimum of four sets of operating and maintenance manuals, as specified in Sections of Division 1.

B. The testing and balancing report shall be submitted and received by the Engineer at least fifteen calendar days prior to the contractor's request for final observation time frame requirements. Include in the O & M Manual after review with "No Exceptions Taken" has been accomplished.

C. In addition to the information required above for Maintenance Data, include the following information:
   1. Description of mechanical equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions. Provide any test reports and start-up documents.
   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions, lubrication charts and schedules, including Contractor lubrication reports.

5. Manufacturer's service manuals for all mechanical equipment provide under this contract.

6. Include the valve tag list.

7. Name, Address and Telephone number of party to be contacted for 24-hour service for each item of equipment.

8. Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.

9. Complete parts list. Provide to Owner, recommended spare parts list.

10. Mechanical warranties.

11. Final schedule of values with all mechanical change order costs included and identified.

D. This contract will not be considered completed nor will final payment be made until all specified material, including testing and balancing report and final schedule of values with all mechanical change order costs included and identified, is received in this operating and maintenance report and the manual is reviewed by the Engineer.

1.25 PROJECT CLOSEOUT:

A. In addition to the requirements specified, complete the requirements listed below.

B. The Contractor shall be responsible for the following Mechanical Checklist either by performing and/or coordinating such items prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements.

C. Mechanical Checklist

1.26 WARRANTIES:

A. Refer to individual equipment specifications for warranty requirements. In any case the entire mechanical system shall be warranted no less than one year from the time of acceptance by the Owner.

B. Compile and assemble the warranties specified in Division 23, into the operating and maintenance manuals.

C. Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.
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END OF SECTION 230500
SECTION 230510 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUBMITTALS:
   A. Refer to 23 05 00 Common Work Results for Mechanical for administrative and procedural requirements for submittals.
   B. Product Data: Submit industry standards and manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing pipe or tube weight, fitting type, and joint type for each piping system.
   C. Welding Certifications: Submit reports as required for piping work.
   D. Brazing Certifications: Submit reports as required for piping work.

1.2 QUALITY ASSURANCE:
   A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
   B. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
   C. Welding procedures and testing shall comply with the latest revisions of the applicable sections for B31, of the ANSI/ASME standard codes for pressure piping, noted as follows: B31.1 - Pressure Piping Code / B31.2 - Fuel Gas Piping Code / B31.5 - Refrigeration Piping / B31.9 - Building Service Piping Code.
   D. Before any welding is performed, the contractor shall submit to the Engineer, or his authorized, a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests and his Welding Procedure Specification together with the Procedure Qualification Record as required by ASME Boiler and Pressure Vessel Code.
   E. Each manufacturer or contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these specifications.
   F. Soldering and Brazing procedures shall conform to ANSI Standard Safety Code for Mechanical Refrigeration.

PART 2 PRODUCTS

2.1 GENERAL:
   A. Piping Materials: Provide pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
   B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated,
comply with governing regulations and industry standards for selections, and with pipe
manufacturer's recommendations where applicable.

2.2 STEEL PIPES AND PIPE FITTINGS:

A. Seamless Steel Pipe: ASTM A 53, Grade B, type S or A106 high temperature.


C. Steel Flanges/Fittings: ANSI/ASME B16.5, ASTM A234 (Fire Protection) including bolting and
gasketing of the following material group, end connection and facing, except as otherwise
indicated.

Material Group: Group 1.1.
End Connections: Buttwelding.
Facings: Raised-face.

D. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for
threaded reducer inserts; rated to match schedule of connected pipe (up to 4 inch pipe size).

E. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows
and returns; rated to match connected pipe.

F. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as
determined by Installer to comply with installation requirements.

G. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less
than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2 inches, and
where pipe size is less than 1-1/2 inches, and do not thread nipples full length (no
close-nipples).

2.3 COPPER TUBE AND FITTINGS:

A. Copper Tube: ASTM B 88; Type K or L as indicated for each service; hard-drawn temper,
except as otherwise indicated.

B. Cast-Copper Solder-Joint Fittings: ANSI B16.18.

C. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.

D. Cast-Copper Solder-Joint Drainage Fittings: ANSI B16.23 (drainage and vent with DWV or
tube).

E. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.

F. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in
service indicated.

2.4 CAST-IRON PRESSURE PIPES AND PIPE FITTINGS:

A. Ductile-Iron Pipe: Class 52, ANSI A21.51; AWWA C151; 350 psi pressure rating.

B. Cement-Mortar Lining for Ductile-Iron and Pipe and Fittings for Water: ANSI A21.4; AWWA
C104.

2.5 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.


B. Soldering Materials: All soldering materials shall be lead free.

1. 95-5 Tin-Antimony: ASTM B 32, Grade 95TA. Melting Range 450-470 degrees F.
3. Flux: All flux shall be lead free, water soluble, and compatible with the solder and the materials being joined. ASTM B813-93.

C. Brazing Materials: Except as otherwise indicated, provide brazing materials to comply with installation requirements.

1. Comply with AWSA 5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.
   a. Copper phosphorus -Bcup-5, 15 percent solver content, melting range 1190 to 1480 degrees F.
   b. Silver - BAg-36, 45 percent silver, cadmium-free. Melting range 1195 to 1265 degrees F.

D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

1. Manufacturer: Subject to compliance with requirements, provide piping connectors of the following:
   a. Husky Technologies (Husky SD 4000):

F. Pipe Thread Sealant Material: Except as otherwise indicated, provide all pipe threads with the sealant material as recommended by the manufacturer for the service.

1. Manufacturer: Subject to compliance with requirements, provide piping thread sealant material of the following:
   a. The Rectorseal Corporation
PART 3 EXECUTION

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, and original design, and the referenced standards.

B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION:

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance.

1. Comply with ANSI B31 Code for Pressure Piping.

2. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Only piping serving this type of equipment space shall be allowed.

3. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

4. Use fittings for all changes in direction and all branch connections.

5. Install drains in pressure pipe systems at all low points in mains, risers, and branch lines consisting of a tee fitting, ¾ inch ball valve, and short ¾ inch threaded end nipple and cap with chain.

6. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

7. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals (See Section 23 05 18). Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.

8. Anchor piping to ensure proper direction of expansion and contraction.

9. Coordinate foundation and all other structural penetrations with structural engineer.

3.3 PIPING SYSTEM JOINTS:

A. General: Provide joints of type indicated in each piping system.
B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

C. Braze copper tube-and-fitting joints in accordance with ASME B31.

D. Solder copper tube-and-fitting joints with silver solder or 95-5 tin-antimony. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

E. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31. Provide weld-o-let fittings for two pipe sizes less than main pipe size.

F. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0 degrees F (-18 degrees C) where possible.
   2. Bevel pipe ends at a 37.5 degrees angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
   3. Use pipe clamps or tack-weld joints with 1 inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inch to 20 inch.
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
   5. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.

G. Weld pipe joints of steel water pipe in accordance with AWWA C206.

H. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

3.4 PIPING APPLICATION:

A. Chilled Water Piping Inside Tunnel:
   1. 2 Inches and Smaller:
      a. Schedule 40, black steel with 125 lb. cast iron or 150 lb. malleable iron threaded fittings.
   2. 2-1/2 Inches and Larger:
      a. Schedule 40, seamless or ERW (std. weight 12 inches and over) black steel with flanged or welded joints.

c. Flanges: 150 lb. 300 lb. forged steel slip-on or welding neck type.

d. Bolting: Regular square head machine bolts with heavy hexagonal nuts.

e. Gaskets: Thickness, material and type suitable for fluid to be handled, and design temperature and pressures.

3. Buried Chilled Water Piping:

   a. Refer to Division 230512.

3.5 PIPING TESTS:

A. General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

B. Test all piping systems as specified. Correct leaks by remaking joints. Remove equipment not able to withstand test procedure during test.

C. Work to be installed shall remain uncovered until the required tests have been completed.

D. Piping which is to be concealed shall be tested before being permanently enclosed.

E. As soon as work has been completed, conduct preliminary tests to ascertain compliance with specified requirements. Make repairs or replacements as required.

F. Give a minimum of twenty-four hours notice to Engineer of dates when acceptance test will be conducted. Conduct tests as specified for each system in presence of representative of owner, agency having jurisdiction or his representative. Submit three (3) copies of successful tests to the Engineer for his review. Report shall state system tested and date of successful test.

G. Contractor shall obtain certificates of approval, acceptance and compliance with regulations of agencies having jurisdiction. Work shall not be considered complete until such certificates have been delivered by the Engineer to the Owner.

H. All costs involved in these tests shall be borne by Contractor.

I. System Tests

1. Hydrostatic Test: The test shall be accomplished by hand pumping the system to the specified water pressure, and maintaining that pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four hours.

   a. Chilled water: 100 psig or 150 percent of system pressure, whichever is greater.

2. Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions or existing building conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, the piping system shall be subjected to the gas pressure indicated for that specific system. The piping capped or plugged and water-pumped
with oil free air, or a nitrogen bottle shall be introduced into the entire system to the pressure specified. The system shall maintain that pressure for the duration of a soapy water test of each joint.

3. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

4. Drain test water from piping systems after testing and repair work has been completed.

3.6 UNDERGROUND PIPE INSTALLATION:

A. Clean fittings, nipples and other field joints thoroughly before coating.

B. Protect gray and ductile cast iron pipe installed below grade with polyethylene encasement applied in strict accordance with ANSI/AWWA C105/A21.5.

C. Install ductile iron pipe below grade as prescribed by AWWA C600.

D. Bury all outside water piping minimum 5 feet-0 inches below grade to top of pipe.

3.7 ADJUSTING AND CLEANING:

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31.

B. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

C. Chemical Treatment: Provide hydronic systems with a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.8 COMMISSIONING:

A. Fill system and perform initial chemical treatment.

B. Before operating the system perform these steps:

1. Open valves to full open position.
2. Remove and clean strainers.
3. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).

END OF SECTION 230510
SECTION 230512 - UNDERGROUND PIPE AND CONDUIT SYSTEM FOR SYSTEMS BELOW 250°F

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section specifies piping materials and installation methods common to this section of Division 23 and includes joining materials, piping specialties, and basic piping installation instructions for all soil conditions.

1.2 REFERENCES:

A. ANSI B31.1

1.3 SUBMITTALS:

A. Refer to 23 05 00 Common Work Results for Mechanical for administrative and procedural requirements for submittals.

B. Product Data: Submit industry standards and manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing pipe or tube weight, fitting type, and joint type for each piping system.

C. Welding Certifications: Submit reports as required for piping work.

D. Brazing Certifications: Submit reports as required for piping work.

1.4 QUALITY ASSURANCE:

A. System shall be factory tested and inspected in accordance with the manufacturer's requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Piping Materials: Provide pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Comply with governing regulations and industry standards.

B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Comply with governing regulations and industry standards.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. U.S. Pipe- TR Flex Piping System (or approved equal).

2.2 UNDERGROUND CHILLED WATER SUPPLY AND RETURN PIPE:

A. The underground piping shall be a restrained joint ductile iron pipe system. Restrained joint pipe shall be ductile iron manufactured in accordance with the requirements of ANSI/AWWA C151/A21.51. Push-on joints for such pipe shall be in accordance with ANSI/AWWA
C111/A21.11 "Rubber Gasket Joints for Ductile-Iron Pipe and Fittings." Pipe thickness shall be designed in accordance with ANSI/AWWA C150/A21.50 "Thickness Design of Ductile-Iron Pressure Pipe," and shall be based on laying conditions and internal pressures as stated in the project plans and specifications.

B. Restrained joint fittings and the restraining components shall be ductile iron in accordance with applicable requirements of ANSI/AWWA C110/A21.10 and/or C153/A21.53 with the exception of the manufacture's proprietary design dimensions. Push-on joints for such fittings shall be in accordance with ANSI/AWWA C111/A21.11.

C. Cement mortar lining and seal coating for pipe and fittings, where applicable, shall be in accordance with ANSI/AWW C104/A21.4. Asphaltic outside coating shall be in accordance with ANSI/AWWA C151/A21.51 for pipe and ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 for fittings.

D. Restrained push-on joints for pipe and fittings shall be designed for a water working pressure of 350 psi for sizes 4" through 24" and 250 psi for sizes 30" through 36".

E. Provide polyethylene encasement applied in accordance with ANSI/AWWA C105/A21.5.

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILLING:
A. Excavation and backfill shall be in accordance with Division 23 and the pipe system manufacturer's recommendations.

3.2 UNLOADING, HANDLING, ASSEMBLY AND INSTALLATION:
A. The unloading, handling, assembly and installation of the system shall be done in accordance with the instructions in the manufacturer's installation guide, and as further supplemented by instructions of the manufacturer's representative at the job site. Such representative shall be present during the job installation, testing, system turn-on, and as requested by the contractor or engineer.

3.3 TESTING:
A. Testing work shall be done under the supervision of a manufacturer's representative.
B. Piping shall be hydrostatically tested in the field under pressure of 150 psig.
C. Joints in the outer casing shall be tested to show ground water will not leak into the piping system.

END OF SECTION 230512
SECTION 230518 - PIPING SPECIALTIES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of piping specialties work required by this section is indicated on drawings and schedules and by requirements of this section.

B. Piping specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 sections.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".

2. ASME B 31.9 "Building Services Piping" for materials, products, and installation.

3. Safety valves and pressure vessels shall bear the appropriate ASME label.

4. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

5. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.

B. Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 23.
PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Dielectric Waterways
   a. Victaulic Co.
   b. Perfection Corp.
   c. Flow Design Inc.
   d. Perfection Corp.
   e. Rockford-Eclipse Div.

2. Mechanical Sleeve Seal:
   a. Thunderline Corp.
   b. Metra Flex.

2.2 HYDRONIC PIPING SPECIALTIES:

A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.


2.3 DIELECTRIC WATERWAY:

A. General: Zinc electroplated nipple with non metallic lining for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion. Union style not acceptable.

2.4 MECHANICAL SLEEVE SEALS:

A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation, as manufactured by Link-Seal or equal.

B. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one of the following:

   1. Mechanical Sleeve Seals: Installed between sleeve and pipe.

2.5 FABRICATED PIPING SPECIALTIES:

A. Pipe Sleeves: Provide pipe sleeves of one of the following:
1. **Sheet-Metal**: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3 inches and smaller, 20 gauge; 4 inches to 6 inches 16 gauge; over 6 inch, 14 gauge.

2. **Steel-Pipe**: Fabricate from Schedule 40 galvanized steel pipe; remove burrs. Provide fully welded waterstop/anchor ring fabricated from minimum 1/8 plate, extending minimum 1 inch from O.D. of sleeve, where noted in Part 3.

3. **Iron-Pipe**: Fabricate from cast-iron or ductile-iron pipe; remove burrs.

4. Sleeves for use with firestopping shall be fabricated in accordance with the installation instructions of the firestopping system.

**PART 3 - EXECUTION**

3.1 **INSTALLATION OF PIPING SPECIALTIES**:  
   
   A. **Dielectric Waterway**: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

   B. **Mechanical Sleeve Seals**: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

3.2 **HYDRONIC SPECIALTIES INSTALLATION**:

   A. **Manual Air Vent**: Provide manual air vents at all high points and drops in the direction of flow, of all mains and risers of the hydronic systems, at heat transfer coils, radiation and elsewhere shown and as required for system air venting.

   1. Provide enlarged air collection standpipe where large air quantities can accumulate.

   2. Use a 1/2 inch ball valve with a soft copper tubing discharge pipe directed to a convenient collection point except as noted below.

   3. Use a coin operated air vent inside terminal unit and baseboard radiation enclosures.

3.3 **INSTALLATION OF FABRICATED PIPING SPECIALTIES**:

   A. **Pipe Sleeves**: In fire resistive construction, coordinate the use of sleeves with the firestopping system requirements. See Section 23 05 09. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves where noted below. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.

   1. Below ground and exterior cast-in-place concrete or masonry: Install steel pipe sleeves with waterstop/anchor ring.
2. For core drilled solid concrete or precast concrete with blockouts, no sleeve is required, except provide sheet metal "collar" fastened and caulked to floors required to have extended sleeves.

END OF SECTION 230518
DESCRIPTION OF WORK:

A. This Section includes general duty valves common to most mechanical piping systems.

B. Valves tags and charts are specified in Division 23 Section "Mechanical Identification."

SUBMITTALS:

A. Product Data: including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

QUALITY ASSURANCE:

A. Single Source Responsibility: Comply with the requirements specified in Division-23 Section "Basic Mechanical Requirements," under "Product Options."

B. MSS Standard Practices: Comply with the following standards for valves:

1. MSS SP-72: Ball Valves with Flanged or Butt-Welding Ends for General Service
2. MSS SP-92: MSS Valve User Guide

C. NSF Standard 61: Drinking Water System Components.

DELIVERY, STORAGE, AND HANDLING:

A. Preparation for Transport: Prepare valves for shipping as follows:

1. Ensure valves are dry and internally protected against rusting and galvanic corrosion.

2. Protect valve ends against mechanical damage to threads, flange faces and weld end preps.

3. Set valves in best position for handling. Globe and gate valves shall be closed to prevent rattling; ball and plug valves shall be open to minimize exposure of functional surfaces; butterfly valves shall be shipped closed or slightly open; and swing check valves shall be blocked in either closed or open position.

B. Storage: Use the following precautions during storage:

1. Valves shall be stored and protected against all dirt, debris and foreign material at all times.

2. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.

3. Protect valves against weather. Where practical store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement and protect in watertight enclosures.
PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by the manufacturers listed.

1. Ball Valves:
   a. Apollo
   b. Milwaukee
   c. Nibco
   d. Watts

2. Butterfly Valves:
   a. Keystone/Tyco
   b. DeZurik
   c. Nibco
   d. Bray
   e. Milwaukee

2.2 VALVE FEATURES:

A. General: Comply with MSS-92 1980 "Valve Users Manual".

B. Valve Design: Valves shall have rising stem, or rising stem outside screw and yoke design; except, non-rising stem valves may be used where headroom prevents full operation of rising stem valves.

C. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size. (Control valves shall be sized for required flow.)

D. Operators: Provide the following special operator features:

   1. Handwheels, fastened to valve stem for valves other than quarter turn.

   2. Lever handle on quarter turn valves 6 inch and smaller, except plug valves. Provide a wrench for every plug valve.

   3. Chainwheel operators for valves 2-1/2 inch and larger that are installed 96 inches or higher above finished floor elevation. Provide chains to an elevation of 6'-0" above finished floor elevation.

   4. Worm gear operators of an enclosed weather-proof design shall be provided on all quarter turn valves 8 inches and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems to allow full operation of the valve without interference by the insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45.
G. End Connections: As specified in the individual valves specifications.


   a. Caution: Where soldered end connections are used, use solder having a melting point below 840 °F for gate, globe, and check valves and below 421 °F for ball valves.

2.3 BALL VALVES FOR HYDRONIC SYSTEMS:

A. Ball Valves – 1 inch and Smaller: 150 WSP, 600 WOG, rated for 150 PSI at 350 °F, two piece end entry body style, bronze body conforming to ASTM B584, full port chrome plated brass ball, 15% glass reinforced PTFE seats, PTFE packing, adjustable packing nut blow-out proof stem, vinyl covered steel handle. Provide solder ends or threaded ends to match piping system. Valves shall have a C\textsuperscript{v} value of a full port ball valve. Comply with NSF-61. Apollo 77C-100/200

B. Ball valve options/accessories: Provide the following as required or as specifically indicated:

1. Tee handle for tight fit applications (within enclosures, etc.).
2. Locking handle.
3. Drain.
4. Stem extension.
5. Mounting pads.

2.4 BUTTERFLY VALVES:

A. Chilled Water Butterfly Valves: Ductile iron body conforming to AWWA C-504, ductile iron ASTM A536 disc with 316 stainless steel seating edge, single piece or two piece 416 stainless steel stem, EPDM seat, upper and lower bronze bearing, non-metallic bushing and stem seal, ANSI class 125 flange, rated for 200 psi pressure differential, 200 psi drop-tight shut off dead end service, with downstream flange removed. All valves shall be factory tested to 110% of pressure rating. Provide with valve box and extensions for buried installation.

DeZurik BAW

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Install valves in accordance with manufacturer’s instructions.

B. Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion. Remove special packing materials, such as blocks used which prevents disc movement during shipping and handling.

C. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the position in which it was shipped.
D. Examine threads on both the valve and the mating pipe for form (out-of-round or local indentation) and cleanliness.

E. Examine mating flange faces for conditions which might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size and material, and for freedom from defects and damage.

F. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.

3.2 VALVE SELECTION:

A. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size 2 Inch and Smaller: Solder ends, except in heating hot water and low pressure steam service which shall have threaded ends.

2. Steel Pipe Sizes 2 Inch and Smaller: Threaded or grooved-end.

3. Steel Pipe Sizes 2-1/2 Inch and Larger: Flanged or grooved end.

3.3 VALVE INSTALLATIONS:

Valve Application Table

(Where sizes overlap, contractor has choice of either type)

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>VALVE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underground Chilled Water Piping</td>
<td>Butterfly Valve</td>
</tr>
<tr>
<td>HVAC Hydronic Piping; 3&quot; and smaller</td>
<td>Ball Valve</td>
</tr>
</tbody>
</table>

A. Locate valves for easy access and provide separate support where necessary.

B. Gate and globe valves shall be installed with the stem in the upright position. In overhead horizontal piping, ball valves shall be installed with the handle in the side or bottom of the piping. Butterfly valves shall be installed with the stem within 45 degrees of the horizontal position. The handle of quarter turn valves shall open in the direction of flow. Quarter turn valves with hand wheels or chain wheels shall be located so that the position indicator is visible from the floor without the use of a ladder or climbing on equipment or piping.

3.4 SOLDER CONNECTIONS:

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket, using steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket in same manner.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open gate and globe valves to fully open position.

E. Remove the cap and disc holder of swing check valves with composition discs.
F. Insert tube into valve socket making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to insure even distribution of the flux.

G. Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating the valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.5 THREADED CONNECTIONS:

A. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

D. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.6 FLANGED CONNECTIONS:

A. Align flanges surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using a torque wrench.

3.7 FIELD QUALITY CONTROL:

A. Testing: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.

3.8 ADJUSTING AND CLEANING:

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare to receive finish painting or insulation.

END OF SECTION 230523
PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.

2. NFPA Compliance: Hangers and supports shall comply with NFPA standard No. 13 when used as a component of a fire protection system.

3. UL and FM Compliance: Hangers, supports, and components shall be listed and labeled by UL and FM where used for fire protection piping systems.

4. Duct Hangers: SMACNA Duct Manuals

5. MSS Standard Compliance:

a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-69.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer’s technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer’s figure number, size, location, and features for each required pipe hanger and support.

B. Shop Drawings: Submit manufacturer’s assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

D. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Pipe Hangers and Supports:
2.2 PIPE HANGERS & SUPPORTS:

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-69.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.

2. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Adjustable Clevis Hanger: MSS Type.

1. Steel Pipe, size 3/8" thru 30", Type 1.
2. Non-insulated Copper Pipe, size 1/2" thru 4", Type 1. (PVC Coated)

C. Adjustable Swivel Ring for Non-insulated Pipe: MSS Type.

1. Steel Pipe, size 1/2" thru 8", Type 7.
2. Copper Pipe, size 1/2" thru 4", Type 7 (PVC Coated)

D. Pipe Clamps: MSS Type.

2. Copper Pipe, size 1/2" thru 4", Type 8 (PVC Coated).

E. U Bolts: MSS Type.
1. Steel Pipe, size 1/2” thru 30” Type 24
2. Copper Pipe, size 1/2” thru 8”, Type 24 (PVC Coated).

F. Straps: MSS Type 26.

G. Pipe Stanchion Saddle: MSS Type 37.

H. Yoke & Roller Hanger: MSS Type 43

I. Hanger Rods: Continuous threaded steel, sizes as specified.

J. Hangers:
   1. Hot Pipes:
      a. 1/2” through 1-1/2”: Adjustable wrought steel ring.
      b. 2” through 5”: Adjustable wrought steel clevis.
      c. 6” and Over: Adjustable steel yoke and cast iron roll.
   2. Cold Pipes:
      a. 1/2” through 1-1/2”: Adjustable wrought steel ring.
      b. 2” and Over: Adjustable wrought steel clevis.
   3. Multiple or Trapeze: Structural steel channel (with web vertical and engineered for the specific applications), with welded spacers and hanger rods. Provide cast iron roll and base plate for hot pipe sizes six inches and over. Provide hanger rods one size larger than for largest pipe in trapeze. If the deflection at center of trapeze exceeds 1/360 of the distance between the end hangers, install an additional hanger at mid-span or use a larger channel.

K. Wall Supports for Horizontal Steel Pipe:
   1. ½ inch through 4inches: Offset or straight j-hook.
   2. 4 inches and Over: Welded steel bracket Type 31, 32 or 33 and wrought steel clamp. Provide adjustable steel yoke and cast iron roll Type 44 for hot pipe 200°F and over and for sizes six inches and over.

L. Supports for Vertical Pipe: Steel riser clamp. Type 8.

M. Upper Attachments:
   1. For attaching hanger rods to structural steel I-beams:
      a. Provide adjustable beam clamp, MSS-Type 21. Attach to bottom flange of beam.
   2. For attaching hanger rods to bar joists:
      a. When bottom chord is constructed of structural steel angles, provide square washer. Place hanger rod between backs of the two angles and support with the washer and dual locking nuts on top of the angles. Spot weld washer to angles.
      b. When bottom chord is constructed of round bars, provide Elcen No. 137 bar joint washer or equal.
2.3 CONCRETE INSERTS AND ANCHORS:

A. Inserts: Case shall be of galvanized carbon steel with square threaded concrete insert nut for hanger rod connection; top lugs for reinforcing rods, nail holes for attaching to forms. This type of upper attachment is to be used for all areas having poured in place concrete construction.

1. Size inserts to suit threaded hanger rods.

B. Provide fasteners attached to concrete ceilings that are vibration and shock resistant. Provide hangers for piping attached to concrete construction with one of the following types.

1. Concrete insert per MSS SP 69, Type 18.

2. Powder driven fasteners subject to approval Structural Engineer. Each fastener shall be capable of holding a test load of 1000 pounds whereas the actual load shall not exceed 50 pounds.

3. Self-drilling expansion shields. The load applied shall not exceed one-fourth the proof test load required.

4. Machine bolt expansion anchor. The load applied shall not exceed one-fourth the proof test load required.

C. Anchors: Carbon steel, zinc plated. Installation shall be in holes drilled with carbide-tipped drill bits or by use of self-drilling anchors.

1. Provide anchors suitable for the location of installation and designed to withstand all forces and movements acting in the anchor. Manufacture pipe anchors in accordance with MSS SP 69. Provide a safety factor of four for the anchor installation.

2.4 SADDLES AND THERMAL SHIELD INSERTS:

A. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

B. Protection Shields: MSS Type 40; 180 degrees arc, galvanized steel, minimum 12 inches long, to prevent crushing of insulation.

C. Thermal Shield Inserts: Provide 100-psi minimum compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure. Insert and shield shall cover the entire circumference or the bottom half circumference of the pipe as required by Part 3 of this Specification, and shall be of length recommended by the manufacturer for pipe size and thickness of insulation. For cold piping, calcium silicate shall extend beyond the sheet metal shield to allow overlap of the vapor barrier. Where piping 4 inches and larger is supported on trapeze or pipe rollers, provide double thickness shields. For piping 12 inches and over, provide 600 psi calcium silicate structural insert.

2.5 MISCELLANEOUS MATERIALS:

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
C. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

D. Pipe Alignment Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 EXECUTION

3.1 INSPECTION:
A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION:
A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. Review Structural Drawings to obtain structural support limitations.

B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified. Provide Shop Drawing showing method and support locations from structure.

3.3 INSTALLATION OF BUILDING ATTACHMENTS:
A. Install building attachments within concrete or on structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

B. Existing Construction:
   1. In existing concrete construction, drill into concrete slab and insert and tighten expansion anchor bolt. Connect anchor bolt to hanger rod. Care must be taken in existing concrete construction not to sever reinforcement rods or tension wires.

3.4 INSTALLATION OF HANGERS AND SUPPORTS:
A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install
intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

C. Support fire-water piping independently from other piping systems.

D. Prevent electrolysis and abrasion in support of copper tubing by use of hangers and supports which are plastic coated, or with EPDM isolation strips. Duct tape or copper coated hangers are not acceptable.

E. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.

F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.9 Building Services Piping Code is not exceeded.

H. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

2. Saddles: Install Protection saddles where supported by pipe rollers. Fill interior voids with segments of insulation that match adjoining pipe insulation.

3. Shields: Install galvanized steel protection shields, on all insulated piping 2 inches and less, except where required to be clamped. Where necessary to prevent dislocation, strap shield to pipe with wire ties or “Zip Strips”.

4. Thermal Inserts: Provide thermal shield inserts at all supports for all insulated piping over 2 inches and for all piping required to be clamped. Provide 180 percent inserts at clevis and roller hangers. Provide 360 percent inserts for all trapeze and clamped supports.

I. Install horizontal hydronic and steam piping with the following minimum rod sizes and maximum spacing:

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<th>SIZE (NPS)</th>
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<th>MIN. ROD SIZE-INCHES</th>
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</table>

J. Place a hanger within one foot of each horizontal elbow.

K. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.

L. Support vertical steel and copper piping at every story height but at not more than 15 foot intervals for steel and 10 feet for copper.

M. Where several pipes can be installed in parallel and at same elevation, provide trapeze hangers.

N. Where practical, support riser piping independently of connected horizontal piping.

O. Support steam supply and condensate return pipe runs on adjustable roller hangers.

P. Each pipe drop to equipment shall be adequately supported. All supporting lugs or guides shall be securely anchored to the building structure.

Q. Securely anchor and support plumbing domestic water piping in chases or walls. Use factory manufactured clamps and brackets connected to fixture s, waste/vent piping or brackets connected to studs. Wires or straps will not be permitted.

1. When copper supplies are connected to flush valves, support the tubing by the studs or by a fixture, not by clamping to waste/vent piping.

2. Prevent copper tubes from making contact with steel brackets using fire retardant polyethylene inserts or other dielectric insulating material. Duct tape shall not be used.

R. Install anchors and fasteners in accordance with manufacturer's recommendations and the following:

1. In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable
replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.

2. Powder-driven fasteners may be used only where they will be concealed after the construction is complete. Where an occasional fastener appears to be improperly installed, additional fastener(s) shall be driven nearby (not closer than 6 inches) in undisturbed concrete. Where it is considered that many fasteners are improperly installed, the Contractor shall test load any 50 successively driven fasteners. If 10 percent or more of these fasteners fail, the Contractor shall utilize other fastening means as approved and at no additional cost to the Owner.

3. Hangers for piping and ducts shall be attached to cellular steel floor decks with steel plates and bolted rod conforming to the steel deck manufacturer's requirements. Where the individual hanger load exceeds the capacity of a single floor deck attachment, steel angles, beams or channels shall be provided to span the number of floor deck attachments required.

4. Welding may be used for securing hangers to steel structural members. Welded attachments shall be designed so that the fiber stress at any point of the weld or attachment will not exceed the fiber stress in the hanger rod.

3.5 INSTALLATION OF ANCHORS:

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.9, and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to control movement to compensators.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping. Provide shop drawing for review by Engineer.

3.6 SHEET METAL DUCT HANGERS AND SUPPORTS:

A. Provide in accordance with SMACNA HVAC duct construction standards.

B. Additional Hanger Requirements:

1. 2" to 24" from flexible connections of fans.
2. 2" to 24" from the outlets or flexible connections of VAV control units or mixing boxes.
3. 12" to 36" from the main duct to the first hanger of long branch ducts.
4. 2" to 12" from the ends of all branch ducts and linear diffuser plenums.
5. 2" to 24" from fire damper break-away joints.
6. Hangers at throat and heal of round or square elbows 48" or greater in width.

3.7 EQUIPMENT SUPPORTS:

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
B. Grouting: Place grout under supports for piping and equipment.

C. Concrete bases for the mechanical equipment indoors or outdoors will be provided by the General Contractor only if shown on the architectural or structural drawings. Otherwise, all bases shall be provided by this Contractor.

D. For inertia bases, see Section 23 05 48.

E. Housekeeping bases shall be 4 inches thick minimum, extended 4 inches beyond machinery bedplates.

F. This Contractor shall be responsible for the proper size and location of all bases and shall furnish all required anchor bolts and sleeves. If bases are provided by the General Contractor, furnish him with templates showing the bolt locations.

G. Equipment shall be secured to the bases with anchor bolts of ample size. Bolts shall have bottom plates and pipe sleeves and shall be securely imbedded in the concrete. All machinery shall be grouted under the entire bearing surface. After grout has set, all wedges, shims and jack bolts shall be removed and the space filled with non-shrinking grout. This Contractor shall provide lead washers at all equipment anchor bolts.

H. Construct equipment supports above floor of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

I. Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment. See also Section 23 05 48.

3.8 METAL FABRICATION:

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours at welded surfaces match adjacent contours.

3.9 ADJUSTING:

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe. Cut off the bottom of threaded rods so they are no more than one rod diameter below the bottom nut.
B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. For galvanized surfaces clean welds bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 230529
SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), size of valve, and variations for identification (if any). Only tag valves which are intended for emergency shut-off and similar special uses, such as valve to isolate individual system risers, individual floor branches or building system shut off valves. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

B. Mechanical Identification:

1. Allen Systems, Inc.
4. Industrial Safety Supply Co., Inc.
5. Seton Name Plate Corp.
6. PVC Specialties
7. Marking Systems, Inc. (MSI)

2.2 MECHANICAL IDENTIFICATION MATERIALS:

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.
2.3 PAINTED IDENTIFICATION MATERIALS:

A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping or to match existing size in existing building, but not less than 1-1/4" high letters for ductwork and not less than 3/4" high letters for access door signs and similar operational instructions.

B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated comply with ANSI A13.1 for colors or to match existing building standard identification.

2.4 PLASTIC PIPE MARKERS:

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.

B. Insulation: Furnish 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F. (52 degrees C.) or greater. Cut length to extend 2 inches beyond each end of plastic pipe marker.

C. Small Pipes: For external diameters less than 6 inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2inch.

D. Large Pipes: For external diameters of 6 inches and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Steel spring or non-metallic fasteners.

2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2inches wide; full circle at both ends of pipe marker, tape lapped 3inches.

3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

E. Lettering: Comply with piping system nomenclature as specified, scheduled, shown, or to match existing building lettering nomenclature system and abbreviate only as necessary for each application length.

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
2.5 PLASTIC TAPE:
   A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
   B. Width: Provide 1-1/2 inches wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inches, 2-1/2 inches wide tape for larger pipes.
   C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.6 UNDERGROUND-TYPE PLASTIC LINE MARKERS:
   A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6 inches wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
   B. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.7 VALVE TAGS:
   A. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4 inch high letters and sequenced valve numbers 1/2 inch high, and with 5/32 inch hole for fastener.
      1. Provide 1-1/2 inch diameter tags, except as otherwise indicated.
      2. Fill tag engraving with black enamel.
   B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), and solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
   C. Access Panel Markers: Provide manufacturer's standard 1/16 inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8 inch center hole to allow attachment.

2.8 VALVE SCHEDULE FRAMES:
   A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with non-glare type sheet glass.

2.9 ENGRAVED PLASTIC-LAMINATE SIGNS:
   A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
   B. Thickness: 1/16 inch, except as otherwise indicated.
   C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
2.10 PLASTICIZED TAGS:

A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inch x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.11 LETTERING AND GRAPHICS:

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, scheduled and approved by the Owner/Engineer. Provide numbers, lettering and wording as indicated and approved by the Owner/Engineer for proper identification and operation/maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as designated on the drawings or schedule as well as service.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION:

A. General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow. Existing building identification shall match the existing method which exists in the building.

B. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

C. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

D. Near each valve and control device.

E. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

F. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

G. At access doors, manholes and similar access points which permit view of concealed piping.

H. Near major equipment items and other points of origination and termination.
I. Spaced intermediately at maximum spacing of 25 feet along each piping run, except reduce spacing to 15’ in congested areas of piping and equipment.

3.3 UNDERGROUND PIPING IDENTIFICATION:

A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6 inches to 8 inches below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16 inches, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 VALVE IDENTIFICATION:

A. General: Provide valve tag on valves in each piping system. List each tagged valve in valve schedule for each piping system.

   1. Building services main shut-off valves.
   2. Each individual system main shut-off valves.
   3. Each individual system riser shut-off valves.
   4. Each individual system floor shut-off valves.
   5. Each individual system major branch shut-off valves.

B. Mount valve schedule frames and schedules in mechanical equipment rooms where directed by Architect/Owner/Engineer.

C. Where more than one major mechanical equipment room is shown for project, install mounted valve schedule in each major mechanical equipment room, and repeat only main valves which are to be operated in conjunction with operations of more than single mechanical equipment room.

3.5 ADJUSTING AND CLEANING:

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 230553
SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products and systems, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove that fire hazard ratings for materials proposed for use do not exceed those specified.

D. Codes and Standards:

1. ASHRAE 90.1

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, density, and furnished accessories for each mechanical system requiring insulation. Submit detail product information and installation information for all jacketing systems specified in this section.

1.3 DELIVERY, STORAGE, AND HANDLING:

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:

1. Mechanical Insulation:

   a. Johns Manville Corp.
   b. Owens-Corning Fiberglas Corp.
   c. Knauf Fiber Glass
   d. Manson
   e. CertainTeed
   f. Einsulation
2. Jacketing & Covering Products:

   a. Childers
   b. Ceel-Co
   c. Zeston
   d. Alpha Associates, Inc.

2.2 PIPING INSULATION MATERIALS:

A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated. "K" factor shall be maximum 0.24 at 75 degrees F. mean temperature, jacket with tensile strength of 35 lbs/in, mullen burst 70 psi, beach puncture 50 oz. in/in, permeability .02 perm factory applied vapor barrier jacket and adhesive self-sealing lap joint.

B. Cellular Glass Piping Insulation: ASTM C 552, Type II, Class 2. "K" factor shall be maximum 0.29 at 75 degrees F mean temperature.

C. Calcium Silicate Piping Insulation: ASTM C 533, Type I. "K" factor shall be maximum 0.45 at 500 degrees F. mean temperature, compression strength 200 psi for 5 percent compression, transverse strength 200 psi for 5 percent compression, flexural strength 60 psi.

D. Flexible Closed Cell Piping Insulation: ASTM C 534, Type I. "K" factor shall be maximum 0.27 at 75 degrees F. mean temperature, with a water vapor permeability of 0.10 perm inches or less. Insulation shall be pre-installed on piping, or un-slit to be slipped over piping as a single piece.

E. Jackets for Piping Insulation: ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

   1. Fitting Covers: UV resistant PVC, pre-molded fitting covers, flame spread 25, smoke developed 50. PVC tape for cold systems, serrated tacks or PVC tape for hot systems.

   2. Aluminum Jacketing: Manufactured from T3003 (or T/5005) H14 to H19 aluminum alloy with 3/16" corrugations and shall have a factory attached 1 mil thick polyethylene moisture barrier continuously laminated across the full width of the jacketing. Jacketing shall be .016" thick minimum. Provide matching factory fabricated covers for 90 degrees and 45 degrees elbows, tee fittings, flange fittings valve bodies, blind ends, reducers and other fittings necessary to make the covering system complete, waterproof and weatherproof.

   3. PVC Jacketing: UV resistant PVC, 30 mil thick, flame spread 25, smoke developed 50, factory cut and curled to fit O.D. of insulated pipe. Solvent weld adhesive for sealing joints and seams.

   4. Rubber/Tedlar Jacketing: ASTM-D-1424-63, ASTM-D-774, and ASTM-E-84, manufactured from a combination of heavy fiberglass fabric coated with Hypalon Rubber, fully cured and laminated to a Tedlar facing. Jacketing will also be required to be vapor barrier and shall be laminated to a corrosion resistant aluminized mylar. Jacketing shall be .010" thick minimum, UL Class I rated, acid and alkali resistant, and be both washable and paintable.
Provide factory fabricated aluminum fitting covers with mil-polyethylene vapor barrier for all elbows, tees, flanges, valves, and other fittings. Alpha Associates Style TGH-1000 or equal.

5. Cloth Jacketing Material: Not less than 8 oz. per square yard with adhesives, cement and sealer as recommended by insulation manufacturer for the intended application. PVC premolded fitting covers shall not be provided.

F. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

G. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated and additional finishes as specified.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

B. Workmanship shall be first class and of the highest quality, poor installation or bad appearance as determined by the engineer shall be due cause to reject the entire project in whole and retainage will be withheld until corrective action is completed to the engineer's satisfaction.

3.2 HVAC PIPING SYSTEM INSULATION:

A. Insulation Omitted: Omit insulation on steam condensate piping between steam trap and union; and on hot piping unions, flexible connections, and expansion joints. Insulation may be omitted inside of cabinet unit heaters, convectors and fan coils for hot piping. Cold piping insulation inside fan coil unit cabinet may be omitted provided piping is located over drain pan. Hot and cold piping routed inside air handler units shall be insulated. Omit insulation on strainers in heating water strainers operating below 200 degrees F.

B. Cold Piping (40 degrees F (4.4 degrees C) to ambient):

1. Application Requirements: Insulate the following cold HVAC piping systems:
   a. Chilled water supply and return piping within tunnel.

2. Insulate each piping system specified above with the following types and thicknesses of insulation:
   a. Fiberglass: (ASHRAE): ½ thick for pipe sizes less than ½ inch, 1 inch thick for pipe sizes 1-1/2 inches and up.

3.3 INSTALLATION OF PIPING INSULATION:

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, testing, and acceptance of tests.
C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on cold pipe insulation, and protect to prevent puncture or other damage.
   1. Do not use staples or tacks on vapor barrier jackets.
   2. Seal vapor barrier penetrations with vapor barrier finish recommended by the manufacturer.
   3. Seal fitting covers with PVC tape.
   4. Cover all unions, check valves, and other in-line devices. Mark outer covering with indelible marker to identify item covered.

F. Neatly bevel and seal insulation at all exposed edges.

G. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

H. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

I. See equipment insulation for removable insulation on accessible piping components.

J. See Section 23 05 29 for insulation inserts and shields. Butt pipe insulation against pipe hanger insulation inserts. For all piping apply wet coat of vapor barrier lap cement on butt joints and seal all joints and seams with 3 inch wide vapor barrier tape or band.

K. Flexible Elastomeric Piping Insulation:
   1. Install unslit, by slipping over piping prior to joining, or install pre-insulated soft copper tubing.
   2. Seal butt ends with adhesive.

L. Cellular Glass Insulation:
   1. Apply in a single layer. Secure to pipe with ½ inch wide aluminum bands.
   2. For indoor applications, apply all purpose Kraft paper/aluminum foil/vinyl coating jacket. Seal all lap and butt joints with self seal vapor barrier tape.
   3. For outdoor applications, apply aluminum rubber/Tedlar jacketing as described below.

M. Calcium Silicate Insulation:
   1. Apply in a single layer. Secure to pipe with 1/2 inch wide aluminum bands.
2. For indoor applications, provide canvas jacketing. Adhere joints of jacketing and provide a finish coat of sealant as recommended by the manufacturer.

N. Piping Exposed to Weather: Protect outdoor insulation from weather by aluminum jacketing.

1. Jacketing shall be secured by 1/2 inch wide stainless steel bands located on 24 inch centers. All joints and seams shall be caulked with clear silicone. Locate all longitudinal seams at the bottom of piping to minimize joint exposure to weather. Contractor may propose pre-fabricated sealing and fastening systems, submit samples and product data for approval.

2. On flexible elastomeric pipe insulation apply two (2) coats of manufacturer's approved U.V. resistant finish.

3.4 EXISTING INSULATION REPAIR:

A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation, install new jacket lapping and sealed over existing.

3.5 PROTECTION AND REPLACEMENT:

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 230700
SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Sections:

1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

1.2 SUBMITTALS

A. Concrete Mix Designs: Submit in accordance with ACI 301.

1. Submit substantiating data for each concrete mix design contemplated for use to the Engineer not less than two weeks prior to first concrete placement. Data for each mix shall, as a minimum, include the following:

   a. Mix identification designation (unique for each mix submitted).
   b. Statement of intended use for mix.
   c. Mixture proportions and descriptions.
   d. Water/cementitious materials ratio.
   e. Total air content
   f. Design slump.
   g. Intended method of placement in field.

B. Steel Reinforcement Shop Drawings:

   1. Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices, and supports for concrete reinforcement.
   2. Show locations of approved construction joints, locations of shrinkage pour strips, splices of reinforcing, type of splice used and splice location, grade of all reinforcement used and specifically identify all ASTM A706 and epoxy coated reinforcing.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

   1. ACI 301, "Specifications for Structural Concrete"
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
C. Pre-installation Conference: Conduct conference at project site.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

   1. Portland Cement: ASTM C 150, Type noted in the structural drawings. Supplement with the following:


B. Normal-Weight Aggregates: ASTM C 33, graded.

   1. Maximum Coarse-Aggregate Size: as noted in the structural drawings.

C. Water: ASTM C 94/C 94M

2.4 ADMIXTURES


B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber

2.7 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, and concrete with a water-cementitious materials ratio below 0.50.

C. Proportion normal-weight concrete mixture as defined in the structural drawings.

2.8 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

3.4 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated in the drawings. Saw-cut contraction joints for a depth equal to at least one-fourth of concrete thickness.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

C. Cold-Weather Placement: Comply with ACI 306.1.

D. Hot-Weather Placement: Comply with ACI 301.

3.6 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

3.7 FINISHING SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to be covered with fluid-applied or sheet waterproofing.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces as noted in the drawings.

2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 3/16 inch (4.8 mm).

D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

3.10 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

END OF SECTION 03 30 00
SECTION 02400 - GENERAL UTILITY REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Submittals
2. Inspections
3. Procedures

B. Related Sections:

1. 312000 – Earthmoving
2. 312333 – Trenching, Backfilling
3. 230510 – Basic Piping Material and Methods
4. 334100 – Storm Utility Drainage Piping

1.2 INTENT:

A. The intent of this standard to state the general utility requirements that apply to all utilities on the UCB campus.

1.3 CODES & STANDARDS:

A. The most recent City of Boulder Design & Construction Standards are incorporated by reference into the University’s Standards. When there is a conflict between standards, the more stringent requirement shall apply. The University’s Civil Engineer must approve in writing any deviation from these standards prior to construction.

B. The most recent International Plumbing Code

C. The most recent International Building Code

1.4 PERMITS:

A. Each project which disturbs or modifies an underground utility is required to obtain a Utility Permit from the University’s Facilities Management Department prior to commencing construction.

B. The project is responsible for paying any permit fees associated with the Utility Permit.

1.5 TAP FEES

A. The project is responsible for paying any tap fee (also commonly referred to as an impact fee or a plant investment fee (PIF)) as determined by the University’s Facility Management – Civil Division. Please reference the utility fee schedule.
1.6 SUBMITTALS

A. During Schematic Design, the design engineer shall provide a preliminary utilities plan which:
1. Illustrates proposed methods and alternatives for providing utility service for the project.
2. Include site topography at 2-foot interval contours
3. Illustrate existing utilities, including manholes, within 400 feet of the proposed development.
4. Identify features, such as creeks, drainage facilities, wetlands, floodplain, utility tunnel, and irrigation ditches, that might influence the location of underground utilities.
5. Illustrate the general layout of the proposed utilities including mains and manhole locations.
6. Illustrate a demolition plan which clearly identifies which utility lines are to be abandoned.

B. During Design Development, the design engineer shall submit a Utility Report to the University’s Civil Engineer. This report shall conform to the requirements outlined in the City of Boulder’s Design & Construction Standards for the utility report. The engineer shall submit a utility system analysis showing the impacts of the project on the utility services. In addition, the following items shall be included for review:
1. Demolition plans,
2. Utility plans showing new and existing utilities,
3. Utility details, and
4. An outline specification

C. Construction Document Phase, the design engineer shall submit complete plans and specifications for review which include:
1. Pipe sizes
2. Points of connection
3. Valve details,
4. Thrust blocks (including area)
5. Thrust (restraint) rods (including diameter),
6. Supports,
7. Trenching and bedding details,
8. Hydrant details,
9. Connection and joint details,
10. Vault plans and sections,
11. All existing tunnels and utilities,
12. A demolition plan indicating which lines are to be abandoned,
13. Building penetration details, and

D. Prior to construction:
1. A copy of the manufacturer’s installation recommendations for each kind of pipe must be provided to each foreman and the inspector prior to construction and must be followed during construction unless otherwise instructed.
b. Manufacturer’s description of admixtures used.
c. Manufacturer’s report of visual inspection.

2. Submit a copy of the project’s Stormwater Management Plan (SWMP) for review and approval. Use Best Management Practices (BMP’s). Sediment, debris or other pollutants from construction operations must be managed to prevent flow to the storm drainage system(s). Erosion and sediment management practices must be applied during construction.

3. Submit a copy of the project’s dewatering permit, if applicable.

4. Submit proposed modifications to any existing pre-engineered concrete structure (i.e., manhole, catch basin, or vault). Submittal shall show dimension of any holes and method for preventing excessive damage.

5. Shop drawings

6. Prior to delivery of pipe from each manufacturing lot or run, submit:
   o Test results for external load crushing strength test per Section 11 of ASTM C76 or Section 10 of ASTM C655.

E. At project closeout:

Record Drawings: The Contractor shall safely maintain in good working order at the project site, one copy of all approved plans, specifications, addenda, written amendments, change orders, work change directives, field orders, and written interpretations and clarifications, clearly annotated to describe all changes made during construction. These documents, together with all final samples and Shop Drawings, shall be available for reference at the request of the University. Upon completion of the work, any deviations from the approved design and any pertinent notes and comments regarding construction conflicts shall be transferred to the approved plans and electronic drawing files and subsequently submitted to the University as the “Record Documents” for the project.

1. Submit record drawings of installed utility system piping and products, in accordance with requirements of Section 01720.

2. Submit shop drawings in accordance with the Section 01300.

1.7 NOTIFICATIONS:

A. Notify the CU Project Manager:

1. Not less than 48 hours before performing locates.

2. Not less than 48 hours before commencing work.

3. Not less than 24 hours before laying pipe.

4. Not less than 48 hours before any testing required by these standards.

5. At substantial completion

6. Not less than 48 hours before final inspection.

1.8 INSPECTIONS:

A. Notify the Owner’s Representative not less than 48 hours before inspection time.
B. Inspections are required prior to the following installation activities.

1. **Stockpiled Materials** – Verify that materials meet construction drawings and approved submittals, including but not limited to: bedding material, pipe, fittings, valves, valve boxes, and fire hydrants.

2. **Excavation** – Verify proper trench depths, shoring, spoil pile location, dewatering, and location and protection of existing utilities.

3. **Installation** – Verify proper bedding depth, alignment and grade, clean pipe and lubricants. Inspect piping to determine whether line displacement or other damage has occurred. If inspection indicated poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects, and re-inspect. Inspection of rebar for cast-in-place manhole bases.

4. **Backfill and Compaction** – Verify proper methods of backfill and compaction, depths of lifts, moisture control, backfill material free of large rock and organic or frozen material, and proper compaction effort and passing tests. Verify that warning tape has been installed. Verify that tracer wire has been installed and that it has a passing continuity test.

5. **Testing** – Verify that testing methods comply with UCB Design and Construction Standards. Verify that the Utility Inspector has witnessed all pressure tests of pipe, vacuum testing of manholes, televising of storm and sanitary sewers, and any other testing requirements such as deflection testing the may be required in the project specifications.

6. At any other time required by the contract documents.

C. Final inspection will be performed at completion at final stabilization of grade.

D. If work to be inspected is covered up prior to inspection, and if the University considers it necessary or advisable that covered work be observed, inspected, or tested, the Contractor, at the University’s request, shall uncover, expose, or otherwise make available for observation, inspection, or testing by the University, that portion of the work in question, furnishing all necessary labor, material, and equipment at no cost to the University.

E. If directed, the Contractor shall promptly correct all defective work, whether or not fabricated, installed, or completed, or, if the work has been rejected, remove it from the site and replace it with work that is not defective. The Contractor shall pay all claims, costs, losses, and damages caused by or resulting from such correction or removal (including, but not limited to, all costs of repair or replacement of work by others).

1.9 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications:

1. The manufacturer(s) shall be a firm regularly engaged in manufacture of water system materials and products, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer’s Qualifications:

1. The installation firm(s) must submit documents of qualification and have a
minimum of 3 years of successful installation experience on projects with work similar to that required for project.

1.10 SEPARATION OF UTILITIES:

B. Parallel (Horizontal) Separation: Parallel separations between utility mains and services to provide for adequate trench excavations and maintenance operations shall be as follows. All distances are measured from outside of pipe to outside of pipe:

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1. If the minimum horizontal separation between wastewater pipe and other utility cannot be achieved, then either the wastewater pipe or the other utility pipe should be upgraded to a pressure class pipe for the distance where the minimum separation cannot be achieved.

2. The Utility Engineer may approve any deviation from the minimum separation distances on a case-by-case basis.

B. Pipe Crossings (Vertical) Separation

1. The minimum vertical separation between water and wastewater line crossings, as measured outside of pipe to outside of pipe, shall be 18 inches. The water line shall be constructed above the wastewater line.

   a. If the 18 inches of vertical separation cannot be obtained, and the water line is constructed above the wastewater line, reinforced concrete encasement shall be installed around the sewer pipe per City of Boulder standard drawing 4.06 and extending a distance of 10 feet either side of the center of the water main. OR One length of PVC pressure pipe at least 20 feet long shall be constructed in the sewer and centered under the water main. Joints between the sewer pipe and the special pipe should be encased in a reinforced concrete collar at least 6 inches thick and extending at least 6 inches either side of the joint. This shall be in addition to the use of a pre-manufactured adapter coupling such as a Mission, Fernco, or Caulder coupling with stainless steel tightening bands.

   b. If the water line cannot be constructed above the wastewater line, then vertical separation between the water line and the wastewater line must be at least 18” and sewer joints shall be grouted or encased in concrete a minimum of 10 feet on either side of the crossing, measured from the outside diameter of the water pipe OR sewer pipe shall be replaced with PVC pressure pipe or cased in steel/ductile iron casing pipe for a minimum of 10 feet on either side of the crossing measured from the outside diameter of the water pipe.
2. The minimum vertical separation between water and storm drainage line crossings shall be 18 inches, measured from outside of pipe to outside of pipe.
   a. If the 18 inches of vertical separation cannot be obtained, and the water line is constructed above the storm drainage line, reinforced concrete encasement shall be installed around the storm sewer pipe per City of Boulder standard drawing 4.06 and extending a distance of 10 feet either side of the center of the water main. OR One length of PVC pressure pipe at least 20 feet long shall be constructed in the storm sewer and centered under the water main. Joints between the sewer pipe and the special pipe should be encased in a reinforced concrete collar at least 6 inches thick and extending at least 6 inches either side of the joint. This shall be in addition to the use of a pre-manufactured adapter coupling such as a Mission, Fernco, or Caulder coupling with stainless steel tightening bands.
   b. If the water line cannot be constructed above the storm drainage line, then vertical separation between the water line and the storm drainage line must be at least 18” and sewer joints shall be grouted or encased in concrete a minimum of 10 feet on either side of the crossing, measured from the outside diameter of the water pipe OR the storm drainage pipe shall be replaced with PVC pressure pipe or cased in steel/ductile iron casing pipe for a minimum of 10 feet on either side of the crossing measured from the outside diameter of the water pipe.

3. The minimum vertical separation between wastewater and storm drainage line crossings, as measured outside of pipe to outside of pipe, shall be 6 inches, including the following:
   a. If the storm drainage line is constructed below the wastewater line, then pressure class pipe will be required for ONE of the utility lines to prevent wastewater contamination of storm drainage.

4. When excavating under an existing utility, flowfill shall be used for backfilling under the utility pipe.

1.11 EROSION AND DUST CONTROL:

A. The Contractor shall prevent erosion of soil on the site and adjacent property resulting from utility construction activities. Effective measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operation that will disturb the natural protection. Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and natural vegetation shall be preserved to the greatest extent practical. Stormwater inlets shall be protected to prevent sediment from excavated areas from entering. All BMPs shall be designed as to not restrict the inlets during large storm events which have the potential to cause flooding and damage to campus buildings.

B. If the Contractor is told that off-project area transport of dust is occurring during construction. The Contractor shall immediately increase the level of dust control to their construction activities.
C. It shall be the responsibility of the Contractor to investigate and verify in the field, the existence and location of utilities whether shown on the approved plans or not. The Contractor shall be solely responsible for the protection of all structures or utilities, including pipes, cables, fences or similar items. Permission for the adjustment of existing utilities or other items or structures shall be obtained from the appropriate owners or agents.

1.12 UTILITY LOCATES FOR OUTSIDE CONTRACTORS/PROJECTS:

A. Underground Utility locates must be requested through the Utility Notification Center of Colorado (UNCC) at 1(800) 922-1987 or 811. The contractor may contact the University of Colorado representative in charge of locating for general site information at (303) 961-0875.

B. The contractor must wait 2 business days (not to include the call day) from the time the locate request was made before excavation can commence per Colorado State Law. Under no circumstance other than an emergency is it allowable to commence excavation before this stated time frame.

C. Emergency utility locates must be requested through the Utility Notification Center of Colorado (UNCC) at 1(800) 922-1987 or 811. The contractor may also contact the utility locator directly at (303) 961-0875 during regular business hours. The contractor must give the utility locator 2 hours to respond in person or by telephone. Under no circumstance should excavation commence unless the contractor has spoken with the utility locator and contacted the UNCC. If for some reason the utility locator cannot be reached, the contractor could contact the Facilities Management Service Center at (303) 492-5522 for assistance.

D. Non-University entities that have utilities on the University property are responsible for their own utility locates. The contractor must make sure that these entities have been notified and have shown up before any digging starts.

E. The dig area(s) must be pre marked with white paint. The only exception to this rule is if the contractor meets with the utility locator to point out the specific dig area(s). The contractor must also make every attempt to adequately describe the area when the utility locate is called into the UNCC. Building names and landmarks are extremely helpful when describing campus locations. Each building on campus does have a physical address that can be obtained from Facilities Management web site.

1.13 DAMAGE NOTIFICATION. IF A FACILITY IS DAMAGED, THE FOLLOWING DAMAGE NOTIFICATION PROCEDURE SHALL BE FOLLOWED:

A. Immediately evacuate the area and call 911 if a dangerous or potentially dangerous situation exists.

B. Cease excavation and immediately notify the CU representative to report damage or exposed facility. Assist CU representative in completing a damage report.

C. Immediately call UNCC (1-800-922-1987 or 811) and process a Damage Ticket.
D. Contact facility owner(s) and report the damage.

E. Excavators and owners/operators who fail to use reasonable care will be “presumed liable” for the cost of the damage, including expenses of suit and reasonable attorney fees and any third party injuries or damages. Reasonable care should include all of the guidelines identified under excavator and facility owner/operator responsibilities.

F. Continue excavation only after a facility representative has arrived and given permission to proceed.

1.14 UTILITY TRACE WIRE

A. General Requirements:

1. Every trace wire system installed should have been designed to match the life of the utility it accompanies.

2. The trace wire needs to be continuous, insulated from the earth and grounded on its ends. NO below ground connections accepted.

3. The trace wire should have a minimum 12 AWG size or use NEPTCO RT Series Detectable MuleTape, constructed of solid copper and have a minimum 30 mil polyethylene jacket designed for buried use. The use of solid copper wire type THHN or THWN VW-1 600V, gasoline and oil resistant insulated is the minimum requirement for trace wire.

4. Trace wires must be installed on all underground utility lines that are being installed or replaced if the section of the utility line is 20 feet or more in length.

5. Both trace wire ends must be accessible from the surface and protected in a flush-mounted trace wire box (Snake Pit Magnetized Box). Trace wire boxes must be installed along the utility line every 250 feet. Trace wire boxes must also be installed adjacent to outside walls where utilities enter the building. The trace wire box must be identified as a trace wire box on the outside. The trace wire must be 12 AWG or larger and must be marked to reflect the UNCC color code of the utility being installed. The test points must also be identified to reflect the UNCC color code of the utility being installed.

B. Installation in the Trench

1. The trace wire should not float “somewhere in the trench.” The trace wire will not be wrapped around the pipe in a spiral as this is a source of signal degradation and adds physical stress to the wire. The trace wire will be placed on top of the utility pipe and will be fastened in place at approximately every 8 to 12 feet to secure it in place when the trench is backfilled. Metallic Fasteners are not to be used. The trace wire on fuel pipelines and on gas lines will not be fastened to the top of the pipe. Instead, the wire will be fastened to the pipe with the use of a spacer to keep the wire at a set distance from the pipe.

2. The wire will be allowed some slack to allow for bends in laying and for future installation of joints, splices, tapping saddles, etc. The slack should also be sufficient to
allow small earth movements occurring in compacting trench fill or through natural subsidence.

3. If it is necessary to join the trace wire below ground, the wire should be joined in a permanent bond (braising, cad welding or equivalent) and the joined area insulated and rendered watertight in order to prevent corrosion.

C. Installation of Trace Wire Access Points

1. Any trace wire system will be accessible at a minimum of 2 points, the beginning and the end of the wire. The general design of access points to tracer wire is that the wire will be brought to ground level and a connection point provided for a locator to clip equipment onto the wire. If the contractor laying the new utility needs to join sections of tracer wire, these access points are considered an above ground join and do not need to be extensively insulated. Split bolts (preferred) and wire nuts are options. The join can be taped also.

2. Trace wire in valve boxes are vulnerable to being twisted around valve keys and snapped, or pushed to the bottom of the valve box where they are out of reach and inaccessible to the locator. The problem can be mitigated by correctly installing the trace wire so it enters the valve box near the top where it can be coiled just under the valve cap. This way the utility worker can easily pull the loop out of the way before using the valve.

D. Distance Between Access Points

1. Access to trace wire will in general be at every point the utility has another physical access point. On water, gas and fuel lines all valves below ground are considered access points and trace wire should be accessible at these points. Access points’ distance from each other will thus vary from a few feet up to hundreds of feet depending on the utility and the project. Concentrations of multiple valves on one utility within 10 feet of each other may be simplified to one access point if this is made explicit in the trace wire submission drawings.

2. There normally should be an access point at least every 500 feet. On long utility runs that exceed 500 feet there should be an intermediate access point provided by bringing the trace wire to the ground level and installing an above ground accessible junction box. Where this is a problem the trace wire system may be initially designed with cable that can be demonstrated to carry an adequate signal over longer distances.

E. Termination of Trace Wire

1. The beginning and end of a tracer wire are equally logical places to be brought to the surface. Above ground trace wire termination points will be clearly tagged or labeled as end points. An as-built point-to-point wiring diagram will be provided and mounted next to the termination point. The end points of any trace wire system are also suitable points to place anodes. Anodes have the dual function of providing cathodic protection for the trace wire (thus increasing its life expectancy) and for providing high quality grounds points.

2. Where a new non-metallic utility line taps into an existing metal utility line, the tracer wire should be either terminated at an anode next to the metallic utility or be permanently attached to the metallic line. A tracer wire will not be terminated to or on another tracer wire or metallic utility line unless the two systems are demonstrably compatible. This is
to reduce the potential for rapid corrosion of one system due to a ‘reverse’ cathodic effect.

3. Lateral connections will be designed to be compatible with the trace wire on the main line. If the termination of the lateral at the main line tracer wire is underground, the join will meet all requirements for underground joins applicable to the main line tracer wire. If the join is ‘above ground’, e.g. at a valve for the lateral line, the joint will be a permanent one (split bolt or better) to the main line tracer wire and will be accessible.

4. Where the lateral line effectively terminates/interfaces with a building, the lateral tracer wire line section will be terminated in an appropriate manner for the utility. Where the utility enters a meter, junction box or similar point outside the building, the trace wire should be brought to the surface and terminated by attaching it to the appropriate utility with a suitable fastener/clamp so that it is clearly visible as part of the utility installation (no dangling wires). When the utility access is only available inside the building, the tracer wire will be terminated in a neat manner inside the building and clearly labeled or tagged. It will also need to be grounded.

F. Testing of Trace Wire Systems

1. All trace wire for new utility installations will be tested before acceptance. The test will take the following form:
   a. A standard 5 watt generator will be used to provide an AC current on the wire.
   b. The frequency of the signal from the generator will be initially restricted to 33 kHz or less.
   c. A standard hand held detector will be used to trace the signal.

2. The installed trace wire will be deemed to pass the test if using this set up:
   a. The trace wire is accessible at all access points.
   b. The trace wire can be traced from access point to access point.
   c. Widely-spaced access points can be traced out in the worst case from each ‘end’ to a common meeting point between them.
   d. Depth readings are consistent and accurate to within a 15 to 1 depth to diameter ratio.
SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The most recent University of Colorado Boulder Standards and Specifications apply. Where there is a conflict between standards, the more stringent requirements shall apply.

1.2 SUMMARY

A. This Section includes the following:
   1. Protecting existing trees, shrubs, groundcovers, plants, grass, and other vegetation to remain or as designated by Owner in pre-construction conference.
   2. Removing existing trees, shrubs, groundcovers, plants, grass, and other vegetation.
   3. Clearing and grubbing.
   4. Stripping and stockpiling topsoil.
   5. Removing above- and below-grade site improvements.
   6. Disconnecting, capping or sealing, and abandoning site utilities in place and removing site utilities.
   7. Removing existing fill.

B. Related Sections include the following:
   1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
   2. Division 31 Section “Temporary Erosion and Sedimentation Control” for storm water erosion and sediment mitigation.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.
1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to be stockpiled or to remain on Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions. Information required may also be included in Division 1 Section "Project Record Documents."

1.6 QUALITY ASSURANCE

A. Preconstruction Conference: Conduct conference at Project site as directed by Owner’s Representative prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing indicated removal and alteration work on property adjoining Owner’s property will be obtained by Owner before award of Contract. Authority and permits for performing indicated removal and alteration work on adjacent rights-of-way shall be obtained by Contractor.

1. Do not proceed with work on adjoining property until directed in writing by Owner’s Representative.

C. Protect improvements on Owner’s property.

D. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

E. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

F. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.
G. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving," (PART 2 – PRODUCTS).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks, survey control points, monuments, property line pins and other reference points from disturbance during construction. If disturbed or destroyed, restore or replace at no cost to Owner.

B. Provide erosion control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust from leaving project site.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.
   1. Restore or replace damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

A. Erect and maintain temporary fencing around drip line of individual trees or around perimeter drip line of groups of trees to remain before starting site clearing. Remove fence when construction is complete.
   1. Do not store construction materials, debris, or excavated material within fenced area.
   2. Do not permit vehicles, equipment, or foot traffic within fenced area.
   3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
   1. Cover exposed roots with burlap and water regularly.
   2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
   3. Coat cut faces of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
4. Cover exposed roots with wet burlap to prevent roots from drying and backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Owner’s Representative.
   1. Employ a qualified arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
   2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

A. Contractor will locate, identify, arrange for disconnect and seal or cap off utilities indicated to be removed before site clearing.
   1. Verify that utilities indicated as abandoned have been disconnected and capped before proceeding with site clearing.
   2. Arrange with utility companies having jurisdiction to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Owner’s Representative not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Owner’s Representative’s written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Removal of underground utilities may also be included in Division 2 Sections covering site utilities. Removal of underground utilities may also be included in Division 15 Mechanical or Division 16 Electrical Sections.

E. After removal of underground utilities, as indicated, properly cap and/or plug existing lines to remain in accordance with authorities having jurisdiction.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Grind stumps and completely remove roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
   4. Use only hand methods for grubbing within drip line of remaining trees.
5. Chip removed tree branches and stockpile in areas approved by Owner’s Representative or dispose of off-site as directed by Owner’s Representative.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earth moving is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered or as determined by Geotechnical Engineer in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 72 inches (1800 mm) unless authorized by Owner’s Representative.
2. Do not stockpile topsoil within drip line of remaining trees.
3. Dispose of excess topsoil as specified for waste material disposal.
4. Stockpile surplus topsoil to allow for respreading a thicker layer of topsoil.

3.6 SITE IMPROVEMENTS

A. Remove existing above and below grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated on plans.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

C. Remove existing fill. Refer to Geotechnical Investigation and/or drawings for information regarding suitability for re-use and estimates of location/extent of existing fill.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner’s property.
1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311000
SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply if provided, to this Section.

B. Additional information concerning earth moving may be found on the civil drawings, in the project geotechnical report and University of Colorado at Boulder construction standards and specifications. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing and grading subgrades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
2. Excavating and backfilling for buildings and structures including overexcavation of existing unsatisfactory on-site soil materials and replacement with structural fill.
3. Drainage course for slabs-on-grade.
4. Subbase and base course for asphalt or concrete paving.
5. Subsurface drainage backfill for walls and trenches.

B. Related Sections include the following:

1. Division 31 Section "Site Clearing" site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.
3. Division 31 Section “Temporary Erosion and Sedimentation Control” for erosion and sedimentation control measures.

C. Permits and Fees: Obtain and pay for all permits and fees required for the work of this section, including erosion and sediment control and water quality permits required by the University of Colorado at Boulder and the Colorado Department of Public Health and Environment, Water Quality Control Division.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.
C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill approved by Geotechnical Engineer.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of all material of whatever character required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders. See Section 3.4 for definition of unclassified and classified excavation.

G. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed or approved by Owners Representative and the testing and inspections agency to correct unsatisfactory conditions. Authorized additional excavation and replacement material will be paid for according to Contract Provisions for changes in the Work.

H. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.

I. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owners Representative. Unauthorized excavation including disposition of overexcavated materials and other work resulting from slides, cave-ins, swelling, upheaval, or remedial work, as well as remedial work directed by Owners Representative, shall be without additional compensation.

J. Fill: Fill is all material placed to raise the grade of the site or to backfill excavation, upon which the Geotechnical Engineer has made sufficient tests and observations to enable him to issue a written statement that, in his opinion, the fill has been placed and compacted in accordance with the requirements of these specifications.

K. Flow Fill: Self-compacting backfill material used as an alternative to compacted granular fill.

L. Structural Fill: Select granular material for use below floor slabs and to 5-feet-0-inches beyond building lines. On-site material may be used if approved by the Geotechnical Engineer.

M. Underslab Gravel: Imported Class 6 road base per Colorado Department of Transportation Standard Specifications for Road and Bridge Construction (current addition) or material approved by Geotechnical Engineer.

N. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for Bulk Excavation or 3/4 cu. yd. (0.57 cu. m) for footing, trench, and pit excavation which in the Geotechnical Engineer’s opinion cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force
of not less than 28,090 lbf (125 kN) and stick-crowd force of not less than 18,650 lbf (83 kN); measured according to SAE J-1179.

2. **Bulk Excavation**: Late-model, track-mounted loader; rated at not less than 210-hp (157-kW) flywheel power and developing a minimum of 48,510-lbf (216-kN) breakout force with a general-purpose bare bucket; measured according to SAE J-732.

**O. Structures**: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

**P. Subbase Course**: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

**Q. Subgrade**: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

**R. Utilities**: Include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 **SUBMITTALS**

**A. Material Test Reports**: Provided by Contractor from a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.

**B. Preexcavation Photographs or Videotape**: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 **QUALITY ASSURANCE**

**A. Comply with applicable codes, ordinances, regulations, references and standards in effect at bid date:**

3. State and local codes.

**B. In case of conflict between the above codes, regulations, references and standards and these specifications, the more stringent requirements shall govern.**

**C. Testing Agency**: The Contractor will employ a qualified independent Geotechnical testing agency. Contractor shall furnish testing agency access to work, facilities and incidental labor.
required for testing. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing.

D. Geotechnical Engineer: All materials and operations under this section of the specifications shall be executed under the supervision of a Geotechnical Engineer who will place qualified personnel on the site during earth moving operations as necessary.

The Geotechnical Engineer shall approve all foundation excavations and give written approval of the completed foundations to the Owner’s Representative at the following times:

1. When excavations are first open.
2. Just prior to placing of concrete, shall test and control the fill compaction, approve the materials and method of placing and compacting and give written approval to the Owner’s Representative that all bearing surfaces and fill requirements have been inspected.
3. The Contractor shall be responsible to notify the Geotechnical Engineer when tests are to be made.

E. For approval of imported or on-site fill material, notify the Geotechnical Engineer at least four (4) working days in advance of intention to import material, designate the proposed borrow area and permit the Geotechnical Engineer to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material. The Geotechnical Engineer report on the acceptability shall be final and binding.

F. Reference Standards:


G. Preconstruction Conference: Conduct conference at Project site as directed by Owner’s Representative prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locations, sizes and depths or invert elevations of existing utilities as shown on the drawings are believed to be correct, but may not be absolutely so. Such information is therefore presented only as approximations, and should be verified prior to construction. Protect from damage any sewer, water, gas, electric, phone or other pipe lines or conduits uncovered during the work until they have been examined by the Owner’s Representative. If such lines are found to be abandoned and not in use, remove affected sections without extra cost. If such lines are found to be in use, carefully protect and carry on work around them. If Owner’s Representative deems it advisable to move such lines, Owner will pay cost of moving. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner’s Representative and then only after arranging to provide temporary utility services according to requirements indicated.

1. Contact utility-locator service for area where project is located before excavating.
2. Notify Owner’s Representative not less than two (2) days in advance of proposed utility interruptions.
3. Do not proceed with utility interruptions without Owner’s Representative's written permission.
B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Remove all existing fill deemed by Geotechnical Engineer to be unsatisfactorily placed.

D. Existing Contours and Elevations: Contours and spot elevations of existing ground elevations at the site, and approximate elevations of finish grade cuts, fills, and excavations for the Work are shown on Drawings. Contours and elevations for existing ground lines are believed to be correct, but may not be absolutely so. Existing contours and elevations should therefore be considered approximate, and should be verified at the site prior to construction.

E. Verification of Existing Conditions: Visit the site prior to submission of bids. Verify existing conditions, elevations, and contours. In the event of discrepancies between existing conditions and those indicated on the Contract Documents or survey, contact the Owner’s Representative for clarification.

F. Existing Benchmarks: Carefully preserve and maintain existing benchmarks, monuments, property line pins, and other reference points. If disturbed or destroyed, restore or replace by a Professional Land Surveyor at no additional cost to Owner.

G. Frost Protection: When freezing temperatures may be expected, do not excavate to the full depth indicated unless the footing or slabs are to be poured immediately after the excavation has been completed. If placing of concrete is delayed, protect the bottoms of excavations from frost until concrete is placed.

1.7 WARRANTY

Settlement in backfill, fill or in structures built over backfill or fill, which may occur within the specified project warranty period, shall be corrected at no cost to the Owner. Any structures damaged by settlement shall be restored to their original condition by the Contractor, at no cost to the Owner.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Shall meet approval of Geotechnical Engineer and shall be free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Clean, on-site, natural soils, or imported materials, as approved by the Geotechnical Engineer.

C. Unsatisfactory Soils: Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups, as identified by the Geotechnical Engineer.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
D. Backfill and Fill: Approved by Geotechnical Engineer.

E. Structural Fill: Approved by Geotechnical Engineer.

F. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1 ½-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1 ½-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1 ½-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

I. Flow Fill:
   1. Low Strength Concrete (LSC) is defined as Flow Fill in these standards.
   2. Materials, batching, mixing and delivery shall be in accordance with the Colorado Department of Highways Standard Specifications for Road and Bridge Construction and shall meet the specific requirements outlined in the City of Boulder’s Design and Construction Standards, section 9.02.
   3. The minimum desired 28-day compressive strength is 100 PSI

J. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

K. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1 ½-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

L. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

2.2 GEOTEXTILES

A. Subsurface Drainage and Separation Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288. Utilize Mirafi 140N or as recommended by Geotechnical Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
B. Preparation of subgrade for earth moving operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Temporary Erosion and Sediment Control," during earth moving operations. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties and rights-of-way.

D. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

E. Cold Weather Work: Prevent frost from entering bearing stratus upon which construction will take place or in areas where fill will be placed in that season.

3.2 DEWATERING

A. Prevent surface water and subsurface ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
   2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.
   3. Obtain and comply with all provisions of the Colorado Department of Public Health and Environment, Water Quality Control Division, Construction Dewatering Permit.

C. Protection of Persons and Property:
   1. Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the Work, as required by municipal or other authorities having jurisdiction.
   2. Protect adjacent streets, roadways, and properties throughout the entire operation. Protect newly graded areas from destruction by weather or runoff. Protect structures, utilities, sidewalks, pavements, and other improvements from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: All excavation (other than rock excavation) is considered as unclassified and is defined as removal of all material encountered, regardless of soil type.
Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include soil materials, and obstructions. Unclassified excavation is considered normal excavation and no extra costs will be allowed.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. Stability:

1. Slope sides of excavations in compliance with OSHA requirements and local codes or ordinances. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
2. Continuously monitor cut slopes for distress. Take all necessary precautions to safeguard workers, structures, and utilities.
3. Provide all necessary shoring, sheeting, or bracing of sides of excavations required to prevent caving, erosion, and gullying. Provide underpinning of existing structures or other improvements adjacent to excavations which are subject to damage.

C. Unanticipated Conditions: Notify the Owner’s Representative immediately upon finding evidence of previous structures or filled materials which penetrate below designated excavation levels, groundwater or water-bearing strata, or other conditions which are not shown or which cannot be reasonably assumed from existing surveys and geotechnical reports. Secure the Owner’s Representative instruction before proceeding with further work in such areas.

D. Rock Excavation: Includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction. Rock excavation in unconfined areas is defined as removal and disposal of material which in the Geotechnical Engineer’s opinion, cannot be excavated without continuous and systematic drilling and blasting, or continuous use of a suitable ripper or other special equipment.

1. Unanticipated Rock Excavation: Rock excavation that is not indicated on existing surveys or which cannot be reasonably assumed from geotechnical studies of the site and which could not have been anticipated without extensive investigations. Unanticipated rock excavation shall be subject to change order procedures or previously agreed upon unit prices.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10-foot. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

B. Scarify subgrade soils beneath exterior slabs, sidewalks and pavements to a minimum depth of 8-inches, moisture condition and recompact as specified.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Refer to Division 31 Section “Trenching and Backfilling,” for excavating and backfilling of utilities.

3.8 SUBGRADE INSPECTION

A. Proof-roll subgrade below the site concrete walks and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Remove and replace soft areas. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Owner’s Representative, and replace with compacted backfill or fill as directed.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner’s Representative, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Geotechnical Engineer.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Owner’s Representative.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials in approved locations without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
8. Acceptance of subgrade by Geotechnical Engineer.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Refer to Division 31 Section “Trenching and Backfilling,” for excavating and backfilling of utilities.

3.13 PLACEMENT OF FLOW FILL

A. Sufficient mixing capacity shall be provided to permit the flow fill to be placed continuously, without interruption.

B. Flow fill shall be thoroughly mixed prior to discharging to ensure a uniform product. Agitation is required during transportation and waiting time to ensure that the material is in suspension when placed.

C. Flow fill shall be discharged from the mixer truck into the trench to be filled, or by other methods approved by the Owner’s Representative.

D. The flow fill shall be placed continuously and brought up uniformly to a point a minimum of 1-inch above adjacent surfaces (trench walls) to ensure proper drainage of bleed water away from the trench.

E. Flow fill shall be vibrated during and after placement to accelerate the bleeding and evaporation of water and to improve consolidation of the material.

F. Flow fill shall not be placed on frozen ground.

G. Flow fill shall be protected from freezing until it has hardened.

H. When the bleed water subsides, the fill material shall be struck off level with the adjacent pavement and the surface finished with a wood float. After the fill material has sufficiently cured to support anticipated traffic loads, the roadway may be temporarily reopened to normal traffic. It shall be the Contractor’s responsibility to maintain the finished surface of the cured fill material in a safe and driveable condition, until such time that the roadway pavement section is permanently replaced. Alternatively, the Contractor may opt to remove the cured fill.
material to a depth equal to the bottom of the existing pavement, and install a temporary asphalt concrete patch. The foregoing does not preclude permanent pavement restoration immediately after the fill material has sufficiently cured to support anticipated traffic loads, should construction scheduling so permit. Permanent pavement restoration shall be in accordance with these specifications.

I. Flow fill mixing and placement may be started if weather conditions are favorable, when the air temperature in the shade and away from artificial heat is at least 34 degrees Fahrenheit and rising. Mixing and placing shall stop when the air temperature in the shade and away from artificial heat is 38 degrees Fahrenheit or less and falling, and in no case shall flow fill be placed when the air temperature is lower than 34 degrees Fahrenheit.

J. It shall be the Contractor’s responsibility to ensure that the backfilled trench is not exposed to vehicular traffic loads until such time that the fill material has sufficiently cured to support the anticipated vehicle loads. Prior to reopening the roadway to normal traffic, the Contractor shall subject the fill material to a vehicular test load that is reasonably representative of the ultimate loading anticipated. When the fill material supports such vehicular test load without apparent deformation, said fill material shall be deemed sufficiently cured to permit reopening of the roadway to normal traffic.

K. Should it be necessary to reopen the roadway to normal vehicular traffic, before the fill material has sufficiently cured to support the anticipated traffic loads, it shall be the Contractor’s responsibility to provide and install steel plates to bridge over the trench.

3.14 SOIL FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

1. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
2. In areas of fill, scarify natural soil following removal of unsatisfactory material, to a depth of 8-inches.

B. Place and compact fill material in layers to required elevations per the geotechnical report and as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.15 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to optimum or to 3 percent over optimum moisture content for clay soils, or within 2 percent of optimum moisture content for granular soils. Refer to geotechnical study for additional recommendations.
1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content beyond the tolerances described above and is too wet to compact to specified dry unit weight.

### 3.16 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the percentages specified by the University Campus Civil Engineer.

### 3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

   1. Lawn or Unpaved Areas: Plus or minus 0.10 feet.
   2. Walks: Plus or minus 0.10 feet.
   3. Pavements: Plus or minus 0.10 feet.

### 3.18 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:

   1. Place base course material over subbase course under hot-mix asphalt pavement.
   2. Shape subbase and base course to required crown elevations and cross-slope grades.
   3. Place subbase and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
   4. Place subbase and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
   5. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 FIELD QUALITY CONTROL
A. Testing Agency: Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION
A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Owner’s Representative; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS
A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner’s property.

END OF SECTION 312000
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply if provided, to this Section.

B. Additional information concerning trenching and backfilling may be found on the civil drawings, in the project geotechnical study/report and University of Colorado at Boulder construction standards and specifications. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. This Section includes the following:

1. Subsurface drainage backfill for walls and trenches.
2. Excavating and backfilling for utility trenches.
3. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.
4. Excavating and backfilling trenches within building lines.

B. Related Sections include the following:

1. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 31 Section “Earth Moving” for soil materials, site excavating, filling and grading.
3. Division 31 Section “Temporary Erosion and Sedimentation Control” for erosion and sediment control.
4. Divisions 22, and 26 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures, if available.
5. Division 33 Section “Storm Utility Drainage Piping” for storm sewer system installation.

C. Shoring Design: Provide the services of a professional engineer to design all shoring, bracing, and underpinning required to protect the safety of workers and integrity of adjacent existing structures or other improvements.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.
B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as backfill approved by Geotechnical Engineer.

E. Unclassified Excavation: Removal of all material of whatever-character required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders.

F. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed or approved by Owner’s Representative and the testing and inspections agency to correct unsatisfactory conditions. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

G. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.

H. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owners Representative. Unauthorized excavation including disposition of overexcavated materials and other work resulting from slides, cave-ins, swelling, upheaval, or remedial work, as well as remedial work directed by Owners Representative, shall be without additional compensation.

I. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for bulk excavation or 3/4 cu. yd. (0.57 cu. m) for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch (1065-mm) wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,090 lbf (125 kN) and stick-crowd force of not less than 18,650 lbf (83 kN); measured according to SAE J-1179.

2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp (157-kW) flywheel power and developing a minimum of 48,510-lbf (216-kN) breakout force with a general-purpose bare bucket; measured according to SAE J-732.

J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

L. Utilities: Includes on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
1.4 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.

B. Samples: Contractor to submit representative samples of all materials proposed for use in bedding and trench backfilling operations to the testing and inspections agency for analysis and determination of compliance with the requirements specified herein.

C. Material Test Reports: Provided by Contractor from a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.

D. Pre-Excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.5 QUALITY ASSURANCE

A. Testing Agency:

1. All testing and inspections required herein will be performed by an independent testing and inspection agency employed by the Contractor.
2. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing or inspection services.

B. Regulatory Requirements: Comply with all applicable requirements of the Occupational Safety and Health Administration and local and State rules, regulations, and ordinances concerning shoring, bracing, or sloping of excavations and safety of workers. Safety of workers is the responsibility of the Contractor.

C. Coordination: Coordinate scheduling and procedures for trench excavation, bedding, and backfilling with other Sections whose work relates to or is affected by this work.

D. Pre-Construction Conference: Conduct conference at Project site as directed by Owner’s Representative prior to start of construction. Contractor to comply with requirements, which also may be included in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locations, sizes and depths or invert elevations of existing utilities as shown on the drawings are believed to be correct, but may not be absolutely so. Such information is therefore presumed only as approximations and should be verified prior to construction. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by
Owner’s Representative and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Owner’s Representative not less than two (2) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner’s Representative's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Existing Bench Marks: Carefully preserve and maintain existing bench marks, monuments, property line pins, and other reference points. If disturbed or destroyed, restore or replace them at no additional cost to the Owner.

D. Verification of Existing Conditions: Visit the site prior to submission of bids. Verify existing conditions, elevations, and utility locations. In the event of discrepancies between existing conditions and those indicated on the Contract Documents or survey, contact the Owner’s Representative for clarification.

1.7 WARRANTY

Settlement in backfill, fill or in structures built over backfill or fill, which may occur within the specified project warranty period, shall be corrected at no cost to the Owner. Any structures damaged by settlement shall be restored to their original condition by the Contractor, at no cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

Utility Trench Bedding Materials:

1. Agency Requirements: Bedding requirements shall be in accordance with jurisdiction having control over utility and University of Colorado at Boulder construction standards and specifications.

A. Utility Trench Backfill Materials:

1. Earth, loam, sandy clay, sand and gravel, soft shale, or other acceptable materials which are free from organic matter and large clods of earth or stone, may be used for fill. Material shall be moistened as required to facilitate backfilling.

2. If the job excavated material proves to be unsuitable for backfill, the contractor may, if approved by Owner’s Representative, use a pit-run material consisting of rocks less than three (3) inches in diameter and a maximum of 20% passing a No. 200 sieve.
B. Select Backfill:
   1. Suitable material with no stones greater than 1" diameter for concrete pipe and 0.75" diameter for all other pipe. Excavated material which meets the grading requirement may be used for select backfill.

C. Flow Fill:
   1. Low Strength Concrete (LSC) is defined as Flow Fill in these standards.
   2. Materials, batching, mixing and delivery shall be in accordance with the Colorado Department of Highways Standard Specifications for Road and Bridge Construction and shall meet the specific requirements outlined in the City of Boulder’s Design and Construction Standards, section 9.02.
   3. The maximum desired 28-day compressive strength is 100 PSI (not a specification requirement).

D. Unsuitable Utility Trench Materials: Materials unsuitable for bedding and backfilling include highly organic soils, ASTM D2487 Group PT topsoil, and soils containing roots, vegetable matter, trash, and debris.

2.2 ACCESSORIES

A. Shoring and Bracing: Provide all materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross-braces, in good and serviceable condition, as required for safety and by governing authorities.

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.
3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Temporary Erosion and Sediment Control," during earthwork operations.

D. Existing Utilities:

1. General: Location of existing utilities shown on the plans are approximate only. The Contractor shall be responsible to locate all existing underground utilities (horizontally and vertically) in areas of the work. If utilities are to remain in place, provide protection during excavation and backfilling operations. Should uncharted or incorrectly charted piping or other utilities be encountered during excavations, consult the Owner’s Representative immediately for direction. Cooperate with the Utility Agency in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the Utility Agency.

2. Active Utilities: Do not interrupt existing utilities serving facilities occupied and used by the Owner or by adjacent properties, except when permitted in writing by the Owner’s Representative, and then only after acceptable temporary utility services have been provided. Remove or relocate utilities only as indicated or specified.

3. Inactive Utilities: Report inactive or abandoned utilities encountered in excavating or grading operations, and remove, plug, or cap as required. In the absence of specific requirements, plug or cap such utility lines at least 5-feet -0-inches outside new building walls, or as required by local requirements.

4. Removal: Demolish and completely remove from the project site all existing underground utilities indicated to be removed. Coordinate with Utility Agencies for discontinuance of services if lines are active.

E. Protection of Persons and Property:

1. Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.

2. Protect adjacent streets, structures, and other improvements from damage caused by settlement, undermining, washout, and other hazards created by trench excavations.

F. Protect subgrades and trench bottoms soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

G. Cold Weather Work: Prevent frost from entering bearing strata upon which construction will taken place or in areas where fill will be placed in that season.
3.3 DEWATERING

A. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations and to collection or runoff areas. Establish and maintain temporary drainage ditches and diversions away from trench excavations. Do not use trench excavations as temporary drainage ditches.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.
3. Obtain and comply with all provisions of the Colorado Department of Public Health and Environment, Water Quality Control Division, Construction Dewatering Permit.

3.4 SHORING AND BRACING

A. Provide shoring and bracing of excavations as required for safety and by governing authorities. Carry down shoring and bracing as excavation progresses. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

3.5 PAVEMENT REMOVAL AND REPLACEMENT

A. Asphalt Pavement:

1. Score existing surface with a cutting wheel to create clean break line. Leave 6" undisturbed subgrade lip on each side of trench.
2. Compact aggregate base course to 95% per AASHTO T180. Replace pavement in accordance with permit requirements or minimum thickness specified in Section 02513. Compact asphalt to 95% per ASTM D1559.

B. Concrete Pavement:

1. Sawcut existing concrete. Leave 6" undisturbed subgrade lip on each side of trench.
2. Compact aggregate base course to 95% per AASHTO T180. Replace pavement in accordance with permit requirements or minimum thickness specified in Section 02520.

C. Sidewalk and Curb Removal:

1. Cut curbs and sidewalks prior to excavation of the trenches with a pavement saw or pavement cutter. Leave 6" undisturbed subgrade lip on each side of the trench. Haul concrete materials from the site. Do not use for trench backfill.
3.6 EXPLOSIVES

A. Explosives: Do not use explosives.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated on the drawings.

C. Clearance: As indicated.

1. Slope sides of trenches or provide shoulders in accordance with OSHA requirements and as required by Utility Agency standards.
2. Continuously monitor cut slopes and trenches for distress or movement. Provide all necessary shoring and bracing required to protect the life and safety of workmen performing excavation or installing piping or conduit.

D. Trench Bottoms: Excavate trenches a minimum of 3 inches (75 mm) deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course and backfill with a 6-inches layer of crushed stone or gravel prior to installing pipe.

3.8 BEDDING OF PIPES:

A. Pipe bedding material shall consist of the material as specified in this section. Bedding material shall be placed to the required elevation of the pipe invert. Tamping equipment shall be used to thoroughly tamp the bedding material. The moisture content of the material shall be within two (2) percent of optimum.

B. After bedding material has been placed and has been approved and after the pipe has been installed and approved the granular bedding material shall be installed to an elevation 12 inches above the top of the pipe. The granular bedding material shall be placed and compacted in distinct, separate lifts not to exceed six inches of loose depth; except that the first loose lift shall not be higher than the pipe centerline (springline). Compaction shall meet the above requirements utilizing T-bars or mechanical tamping equipment.

C. Set all pipe on compacted granular material supporting the lower half of the pipe barrel. Place compacted granular material around and on top of pipe to not less than 12" deep from top of pipe.
3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials in approved locations without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 UTILITY TRENCH BACKFILL

A. Unless otherwise authorized by the UCB Civil Engineer flowable fill shall be used for backfill under high traffic asphalt roadways. This includes, but is not limited to, any asphalt areas on 18th St., Colorado Ave., Kittredge Loop Rd., Discovery Dr., Euclid Ave., Wardenburg Dr., and Baker Dr.

B. The compaction requirements shall conform to maximum dry density according to ASTM D698, Moisture-Density Relations of Soils (Standard Proctor). When the ASTM D698 test is not applicable, the percentage compaction requirements shall conform to ASTM D2049 Test for Relative Density of Cohesionless Soils.

C. All backfill above the bedding installation shall be carefully placed and compacted. Compaction shall be by mechanical tamping in eight-inch maximum loose lifts using mechanical or hand tampers, suitable for material being compacted, or vibratory rollers. All backfill shall be compacted to 95% of maximum laboratory dry density or 70% relative density. The material shall be within two (2) percent of optimum moisture content.

D. The contractor may request approval of alternate means of compaction. Such request must be submitted to the Owner’s Representative in writing and the approval will be made by the Owner’s Representative in writing. Use of specified or approved compaction methods does not relieve the contractor from providing a complete project meeting the intent of the Design and Construction Standards.

E. When directed by the Owner’s Representative, the contractor shall excavate backfilled trenches for purposes to perform compaction tests at locations and depths determined by the Owner’s Representative. The contractor shall be responsible for reinstalling and compacting the test excavations at no additional cost to the Owner.

F. Do not backfill any pipe trenches until pipe is inspected by University Engineer and owning utilities (if any).

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
C. When testing agency reports that backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.12 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Owner’s Representative; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.13 CLEANING AND ADJUSTMENT

A. Cleanup: Remove excess materials not required for backfilling purposes, including excess spoil material, accumulated debris, and rubbish from site. Burning of waste material is prohibited.

3.14 RESTORATION

A. Adjacent Improvements: Restore all fences, irrigation ditches, yards, lawns, and other structures or surfaces to condition equal to or better than before work began.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 312333
SECTION 312500 - TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply if provided, to this Section.

B. The most recent University of Colorado Boulder Standards and Specifications apply. Where there is a conflict between standards, the more stringent requirements shall apply.

1.2 SUMMARY

A. Work Included. Furnish, install, maintain, and remove temporary erosion and sedimentation controls as shown on the drawings or specified herein, or as required to complete the work.

B. Related Sections include the following:

1. Division 31 Section "Site Clearing" site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 33 Section "Subdrainage" for drainage of foundations slabs-on-grade walls and landscaped areas.
3. Division 31 Section “Earth Moving” for soil materials, site excavating, filling and grading.
4. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.

C. Permits and Fees: Obtain and pay for all permits and fees required for the work of this section, including erosion and sediment control and water quality permits required by the authority having jurisdiction and the Colorado Department of Public Health and Environment, Water Quality Control Division.

D. Erosion Control: The Erosion and Sedimentation Control Drawings included in the Contract Documents is the minimum requirement to be implemented. Provide additional control as necessary to meet applicable local and State criteria.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.
B. Unclassified Excavation: Removal of all material of whatever character required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders.

C. Fill: Fill is all material placed to raise the grade of the site or to backfill excavation, upon which the Soils Engineer has made sufficient tests and observations to enable him to issue a written statement that, in his opinion, the fill has been placed and compacted in accordance with the requirements of these specifications.

D. BMP: Best Management Practice. Erosion and sediment control devices, which may consist of silt fence, rock socks, curb socks, crates, filter fabric, riprap, etc.

E. SWMP: Storm Water Management Plan. Identifies BMPs, which are erosion and sediment control measures for the project.

F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

H. Utilities: Include on-site underground pipes, conduits, ducts, and cables, as well as underground services to buildings.

1.4 SUBMITTALS

A. Submittal Procedures: All submittals are to be made to the Owner’s Representative. If provided refer to Division 1 section “Submittal Procedures.”

B. Product Data: Submit manufacturer’s published descriptive literature and complete specifications for manufactured products specified herein and utilized on the project.

1. Geotextiles.
2. Erosion Control Fabric.

C. Storm Water Management Plan:

1. The Contractor is responsible for obtaining all required permits including a General Permit application for Storm Water Discharges associated with construction activities at least ten (10) days prior to start of construction. Permits are to be filed with the Colorado Department of Public Health and Environment, Water Quality Control Division.
2. Contractor shall have the Storm Water Management Plan (SWMP) and report available on-site at all times.
1.5 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with applicable local, State and Federal ordinances, rules and regulations concerning sedimentation control and storm water runoff.

B. In case of conflict between the above codes, regulations, references and standards and these specifications, the more stringent requirements shall govern.

C. Preconstruction Conference: Conduct conference at Project site as directed by Owner’s Representative prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.6 PROJECT/SITE CONDITIONS

A. Existing Conditions: Verify all existing conditions affecting the work of this section prior to submitting bids or proposals. Additional compensation will not be allowed for revisions or modification of work resulting from failure to verify existing conditions.

1.7 WARRANTY

A. Temporary Erosion and Sediment Control measures shall be maintained until permanent measures are in place. All damaged, disturbed or devices filled with sediment, which may occur within the specified project warranty period, shall be corrected at no cost to the Owner. Any devices damaged by erosion or sediment shall be restored to their original condition by the Contractor, at no cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Erosion and Sedimentation Control Materials: Provide one or more of the following materials, as shown on the plans or as applicable for site conditions:

1. Sand bags.
2. Rock socks.
3. Curb socks.
4. Silt fences.
5. Rock riprap.
6. Temporary seeding.
7. Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh.
8. Biodegradable twisted jute or spun-coir mesh, 0.92 lb/sy minimum, with 50 to 65 percent open area.
9. Drainage geotextile.
10. Impervious fill.
11. Other materials proposed for use on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:

1. Determine the existing ground elevations, drainage patterns, and changes to such patterns during excavation in order to satisfactorily plan and provide materials for adequate erosion and sediment control devices.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and rights-of-way according to requirements of authorities having jurisdiction.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

D. Secure grading permit from agency having jurisdiction prior to commencing grading operations.

3.3 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.4 INSTALLATION

A. Erosion and Sedimentation Control Devices. Erosion and sedimentation control measures to be taken during construction include, but are not necessarily limited to the following:

1. Apply soil stabilization within 14 days to all disturbed areas that are to be dormant for a period longer than 30 calendar days after reaching grade. Stabilize soil with mulch anchored per criteria of authorities having jurisdiction. Temporarily revegetate areas that will remain in an interim condition for more than sixty (60) days.

2. Roads and parking areas indicated to be paved may be covered with an appropriate aggregate base course in lieu of mulch. Temporary mulching or aggregate base course is not required if final pavement construction will take place within 30 days after grading to final contours.

3. Soils that will be stockpiled for more than 30 days must be mulched and seeded within 14 days after stockpile construction.
4. Prevent sediment from leaving the project site by installing a silt fence or other BMPs as indicated on the plans. Protect existing storm inlets adjacent to the site by an approved gravel filter.
5. Locate stone stabilization pads at all points of vehicular ingress and egress to the construction site.
6. Provide temporary erosion controls consisting of berms at the top of slopes and interceptor ditches at ends of berms and at those locations which will eliminate or minimize erosion during construction, along with temporary seeding, temporary diversion, chutes, and down pipes and lining of water courses.
7. Temporary sedimentation controls shall consist of silt dams, traps, silt fence, barriers, and appurtenances at the top of spoil and borrow area slopes and where runoff water exits the site.
8. Maintain the available silt holding capacity of silt dams, fence traps and barriers until no longer needed. The sediment capacity of sediment retainage areas shall be at a minimum, the capacity shown on the plans in conformance with Urban Drainage Criteria Manual, Volume 3. Prior to removal, obtain concurrence of the Owner and Engineer.
9. Remove accumulated sediment and debris from a BMP when the sediment level reaches one-half the height of the BMP, or at any time the sediment or debris adversely impacts the functioning of the BMP.
10. The erosion/sediment control plan shows the minimum required for the project. If it becomes apparent that additional controls are necessary, the Engineer shall be notified and with approval of the Owner’s Representative additional controls shall be installed.

B. Chemicals and Pollutants:
1. Store construction materials and chemicals that could contribute pollutants to the runoff within an enclosure, container, or dike located around the perimeter of the storage area, to prevent discharge of these materials into runoff from the construction site.
2. Locate areas used for collection and temporary storage of solid and liquid waste away from the storm drainage system. Provide covering or fencing as required to prevent windblown materials; construct perimeter dike to contain liquid runoff. These measures may not be necessary if materials are immediately placed in covered waste containers.
3. Perform equipment maintenance in designated areas using measures such as drip pans to control petroleum products spillage.
4. Immediately clean up and properly dispose of spills of construction related materials such as paints, solvents, or other chemicals.

C. Final Stabilization and Long-Term Management: University of Colorado at Boulder
1. Final stabilization shall be achieved through permanent vegetation and landscaping after construction of all buildings and paved surfaces.
2. With approval of University of Colorado at Boulder temporary erosion and sediment control measures may be removed within 30 days after final site stabilization is achieved or after temporary measures are no longer needed.

D. Inspection and Maintenance: Inspect erosion and sediment control measures weekly during construction. In addition, inspect all facilities immediately after any significant runoff or snowmelt which results in runoff. Repair or otherwise mitigate any damage to the erosion and sediment control facilities at no additional cost to the Owner.
3.5 CLEANING

A. Removal of Controls: Remove controls upon completion of that portion of the work for which controls were furnished. Leave the site and work area in a clean condition.

END OF SECTION 312500
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply if provided to this Section.

B. Additional information concerning asphalt paving may be found on the civil drawings, in the project geotechnical report (if available) and University of Colorado, Boulder construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving overlay.
4. Asphalt surface treatments.
5. Cold milling of existing hot-mix asphalt pavement.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling and site grading.
2. Division 32 Section “Pavement Markings” for pavement striping and symbols.

C. References:

2. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition and all appropriate standard special provisions.
3. Reference Standards: Comply with the requirements of the reference standards noted herein, except where more stringent requirements are described herein or otherwise required by the Contract Documents.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. CDOT: State of Colorado Department of Transportation.

C. CDOT Specifications: Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition and all appropriate standard special provisions.
1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving in accordance with Section 401 of the CDOT Specifications.
   2. Measurement and payment provisions and safety program submittals included in CDOT Specifications do not apply to this Project.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated, include technical data and tested physical and performance properties.

B. Job-Mix Designs: For each job mix proposed for the Work.

C. Material Test Reports: For each paving material.

D. Material Certificates: For each paving material, signed by providers.

1.6 QUALITY ASSURANCE

A. Manufacturer and Installer Qualifications:
   1. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.
   2. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Testing Agency:
   1. All testing and inspections required herein will be performed by an independent testing and inspection agency employed by the University of Colorado at Boulder.
   2. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing or inspection services.

C. Testing Requirements: Asphalt Paving shall be tested for gradation, asphalt content and in-place density in accordance with CDOT Specifications, the current edition of CDOT Field Materials Manual, and local Regulatory Agency requirements, whichever are the most stringent.

D. Preconstruction Conference: Conduct conference at Project site as directed by Owner’s Representative. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
1. Tack Coats: Minimum surface or air temperature in the shade of 60 deg F (15 deg C).
2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
3. Asphalt Base Course: Minimum surface or air temperature in the shade of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface or air temperature in the shade of 50 deg F and rising at time of placement.

B. Coordination and Scheduling:

1. Cooperate with other trades and arrange scheduling to avoid damage to other work, including grading, site utilities and piping, exterior concrete, landscaping and irrigation systems.
2. Before commencing pavement operations, ascertain that utility lines, site lighting and wiring, piping, curb and gutter work, general grading and heavy trucking is complete so that such operations will not damage paving work.
3. Mask off and protect exposed building surfaces and abutting concrete from damage or staining by tack coat and paving operations.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations meeting the requirements of the CDOT Specifications.

B. Asphalt Concrete Aggregate: Clean, hard, durable particles of crushed stone, crushed slag, crushed gravel, or natural gravel conforming to the requirements of Subsection 703.04 of the CDOT Specifications and Grading SX and S (Table 703-4).

C. Mineral Filler: Rock dust, slag dust, hydrated lime, hydraulic cement, or other suitable mineral material conforming to the requirements of Subsection 703.06 of the CDOT Specifications.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: The asphalt cement to be used on this project shall be PG 64-22 conforming to the requirements of Subsection 702.01 of the CDOT Specifications.

B. Tack Coat: AASHTO M 140, emulsified asphalt or AASHTO M 208, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Fog Seal: AASHTO M 140, emulsified asphalt or AASHTO M 208, cationic emulsified asphalt, slow setting, diluted at the factory in water, of suitable grade and consistency for application.

D. Water: Potable.
2.3 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes. Furnish job-mix formulas for each pavement type, conforming to the requirements of Subsection 401.02 of the CDOT Specifications. Mix aggregates and bituminous materials in accordance with the requirements of Subsection 401.15 of the CDOT Specifications. Use approved job mix formulas. Mix to comply with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: Grading S.
3. Surface Course: Grading SX.

B. Emulsified-Asphalt: Shall conform to AASHTO M140 or M208 in accordance with Subsection 702.03 of the CDOT Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is unfrozen, free of water, snow, and ice otherwise in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction. Scarify, regrade and recompact surface of subgrade that is pumping or deforming as required to provide true levels, uniform slopes and proper total thickness of paving as required in Division 31 Section “Earth Moving.”

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of a minimum 1½-inches or as indicated on the plans.
2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.
3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.2 gal./sq. yd. (0.2 to 0.8 L/sq. m).
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch (6 mm).
   1. Clean cracks and joints in existing hot-mix asphalt pavement.
   2. Use emulsified-asphalt slurry to seal cracks and joints less than ¼ inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
   3. Use hot-applied joint sealant to seal cracks and joints more than ¼ inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

C. Hot-applied joint sealant being a single-component formulation complying with ASTM D 3405 or D1190.
   1. Refer to CDOT Standard Specification, Section 702.06 for joint and crack sealant material requirements.
   2. Refer to CDOT Standard Specification, Section 408.01 and 408.03 for joint and crack sealant installation requirements.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
   1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.20 gal./sq. yd. (0.2 to 0.8 L/sq. m).
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated on the plans or as directed by Geotechnical Report. Maximum lift thickness shall be 3-inches. Minimum lift thickness shall be 1½-inches for Grading SX and 2-inches for Grading S.
2. Place hot-mix asphalt surface course in single lift. Maximum lift thickness shall be 2-inches.
3. Spread mix at minimum temperature of 235 deg F (113 deg C) per in accordance with Subsection 401.15 of the CDOT Specifications, Table 401-5.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150mm).
3. Offset transverse joints, in successive courses, 6 to 12 inches (150-300 mm).
4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. When paving surface temperature falls below 185 deg F (85 deg C) no further compaction effort will be permitted unless approved.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density in accordance with Subsection 401.17 of the CDOT Specifications.

1. Pavement shall be compacted to a density of 92% to 96% of the maximum theoretical density, determined according to Colorado procedure 51. Field density determination will be in accordance with Colorado Procedure 44 or 81.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
1. Base Course: Plus or minus ¼ inch (6 mm).
2. Surface Course: Plus ¼ inch (6 mm), no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

1. Base Course: ¼-inch (6 mm).
2. Surface Course: 3/16-inch (5 mm).
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is ¼-inch (6 mm).

3.10 MANHOLE FRAME ADJUSTMENTS

A. Set frames for manholes and other such units within areas to be paved to ¼-inch minimum to ½-inch maximum below final grade as part of this work. Include existing frames or new frames furnished under other sections of these specifications.

B. Set cover frames to ¼-inch minimum and ½-inch maximum below surface of adjacent pavement. Surround frames set to grade with a ring of compacted asphaltic concrete base prior to paving. Place asphaltic concrete mixture up to 1-inch below top of frame, slope to grade, and compact with hand tamping. Adjust frames as required for paving.

C. Provide temporary closures over openings until completion of rolling operations. Remove closures at completion of work.

3.11 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F (121 deg C).

1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With a fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.
3.13 FIELD QUALITY CONTROL

A. Testing Agency: University of Colorado at Boulder will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
   1. Testing agency will conduct and interpret tests and state in each report whether tested work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
   1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
   2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
      a. One core sample will be taken for every 350 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
      b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Asphalt Content and Gradation. Testing agency will take sample of uncompacted paving mixtures at a minimum frequency of every 1,000 tons according to Colorado Procedure – Laboratory CPL-5120 and Colorado Procedure CP-31.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements. Conforming to the specified requirements will be in accordance with Subsection 105.03 of the CDOT Specifications.

3.14 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from project site and legally dispose of them in an EPA-approved landfill.
   1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 32 1216
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes constructing exterior concrete paving on prepared subgrade or base course in accordance with these specifications. This work shall be in conformity with the lines, grades, thicknesses and typical cross-sections required within CU standard and as shown on the plans for the following. In case of conflict, CU standards are to be met at a minimum:

1. Driveways and roadways.
2. Parking lots.
3. Curbs and gutters.
4. Sidewalks, steps, ramps.
5. Base material for unit paver.
6. Dumpster and loading dock pads.
7. As detailed on the plans.

B. Related Sections include the following:
1. Divisions 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
2. Division 32 Section “Pavement Marking” for pavement striping and symbols.
3. Division 32 Section “Concrete Pavement Joint Sealants” for expansion and contraction joints.

1.3 REFERENCES


B. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

B. CDOT: State of Colorado Department of Transportation.


F. Refer to ACI 301: (American Concrete Institute – Standard Specifications for Structural Concrete), for additional definitions.

1.5 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete pavement mix, and includes alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
   1. Aggregates.
   2. Cement.
   3. Admixtures.

D. Material Certificates: Signed by manufacturers certifying that each of the following materials used in the project complies with requirements:
   1. Cementitious materials and aggregates.
   2. Steel reinforcement and reinforcement accessories.
   3. Fiber reinforcement.
   4. Admixtures.
   5. Curing compounds.
   7. Bonding agent or adhesive.
   8. Joint fillers.

E. Field quality-control test reports.

F. Pavement Joint Layout Plan: Plan to show joint locations and typical dimensions for review and approval by CU representative and engineer.

G. Traffic Control Plan: For work in the public right-of-way.

H. Pedestrian Control Plan for Walkways
1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94/C 94 M requirements for production facilities and equipment.
   1. Manufacturer must be certified according to the National Ready Mix Concrete Association's (NRMCA) Plant Certification Program.

C. Testing Agency Qualifications: An independent agency qualified according to ASTM C1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant and each aggregate from one source.

E. ACI Publications: Comply with ACI 301, “Specification for Structural Concrete,” unless modified by the requirements of the Contract Documents.

F. Concrete Testing Service: The Owner will engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preconstruction Conference: Conduct conference at project site as directed by Owner’s Representative prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section “Project Management and Coordination.”

H. Regulatory Requirements:
   I. Comply with CU standards for sidewalks, curbs, ramps, gutters, and driveway approaches or aprons, including standard dimensions, profiles, thicknesses, reinforcing, and compressive strength. In the event of conflict between the Contract Documents and the standards, the more stringent requirements will apply.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities, and where required by the Traffic Control Plan.

B. Coordination and Scheduling: Coordinate with other trades and arrange scheduling to avoid damage to other work including grading, site utilities and piping, asphalt paving, landscaping and irrigation systems.
C. Field Measurements: Verify dimensions and existing conditions shown on the drawings by taking field measurements prior to start of work. Report discrepancies to the Owner’s Representative for clarification and make minor adjustments in layout as required by field conditions and as approved by the Owner’s Representative, at no additional cost to the Owner.

D. Environmental Requirements: Perform work only under suitable weather conditions. Comply with the environmental requirements of Section 3.6 for concrete placement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2. Products: Subject to compliance with requirements, provide one of the products specified.

3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves of a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Fabric: CDOT Section 709 and ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Reinforcement Bars: CDOT Section 709 and ASTM A 615/A 615M, Grade 60, deformed. Cut bars true to length with ends square and free of burrs.

C. Joint Dowel Bars: Plain steel bars, CDOT Section 709 and ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

D. Tie Bars: CDOT Section 709 and ASTM A 615/A 615M, Grade 60, deformed.
E. Supports for Reinforcement: Chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 COLORED ADMIXTURE

Colored Admixture: L.M. Scofield Co. “Chromix” or Rockwood Industries “Davis Colors”, color as selected by Owner’s Representative. Use for colored concrete where indicated on the drawings.

2.5 EXPANSION JOINT FILLER

A. Sealed Joints: Preformed, compressible fiber or cork filler material complying with ASTM D1751 or D1752, Type II, guaranteed compatible with expansion joint sealant materials, ½-inches thick unless otherwise indicated. Provide high-impact polystyrene removable “void cap” to create ½-inches deep reveal for installation of sealant.

B. Self-Sealing Joints: Preformed, compressible asphalt fiber joint filler complying with ASTM D994, ½-inches thick unless otherwise indicated. Do not use asphalt fiber filler in joints to receive elastomeric joint sealants.

2.6 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: CDOT Section 701 and ASTM C 150, Type [I/II]
   a. Fly Ash: ASTM C 618, Class [F].

B. Normal-Weight Aggregates: CDOT Section 703 and ASTM C 33, coarse aggregate, uniformly graded. Provide aggregates from a single source.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Do not use fine or coarse aggregates containing substances that cause spalling.

C. Water: CDOT Section 712 and ASTM C 94/C 94M potable.

2.7 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.
B. Air-Entraining Admixture: CDOT Section 711 and ASTM C 260.

C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C494, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
7. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.8 CURING MATERIALS: CDOT SECTION 711

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq.yd. (305 g/sq.m) dry.

B. Moisture-Retaining Cover: ASTM C 171, waterproof paper, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B.
1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.

F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type II, Class B.
1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.

2.9 CONCRETE MIXTURES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
1. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.
2. Do not use Owner's field quality-control testing agency as the independent testing agency.

B. Proportion mixes to provide concrete with the following properties:
1. Compressive Strength (28 Days): 4,000 psi
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: \(0.45\)
3. Slump Limit: 4 inches (100 mm).
4. Minimum 564 lb. Cement per cubic yard. (CDOT Class P)

C. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 4.0 to 7.0 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to \(0.15\) percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing admixture plasticizing and retarding admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals as follows:
   1. Fly Ash: 20 - 30 percent Class F Fly Ash CDOT Section 601.02, Class P Concrete.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
   1. Completely proof-roll subbase in one direction [and repeat in perpendicular direction]. Limit vehicle speed to 3 mph (5 km/h).
   2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
   3. Subbase with soft spots and areas of pumping or rutting exceeding depth of \(1/2\) inch require correction according to requirements in Division 2 Section "Earth Moving."

C. Subgrade shall be tested by Geotechnical Engineer and pass required tests prior to concrete pavement placement.
D. Proceed with concrete pavement operations only after non-conforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinfacing Bars" for placing and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 12-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Construct/install construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

2. Contractor to provide plan of joint placement for the Engineers approval.

3. The distance between joints shall meet dimension indicated on plans and shall not exceed in feet, twice the pavement thickness in inches. (i.e.: 6-inches PCC pavement to utilize maximum 12-foot joint spacing.)

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at expansion joints.
1. Contractor may utilize preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.

3. Provide tie bars at sides of pavement strips where indicated.

4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

C. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints in pavement where indicated on plans.

2. Extend joint fillers full width and depth of joint.

3. Terminate joint filler no less than 1/2 inch or no more than 1 inch below finished surface for joint sealant.

4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

5. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the indicated radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

3. Tied Contraction Joints: Install deformed bars and support assemblies at joints where indicated.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
D. Comply with ACI 301 and ACI 304R requirements and recommendations for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery to the project site.

F. Do not add water to fresh concrete after testing.

G. Do not add water to concrete surface during finishing operations.

H. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

I. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

L. Curbs and Gutters: Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified with expansion joints at intervals of approximately 100 feet and tooled contraction joints at 10-foot intervals unless adjacent sidewalk/plaza jointing differs in which case the joint spacing should match sidewalk joint spacing. When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements.

M. Walks: Minimum 4-inches or 6-inches thick as indicated, with expansion joints at intervals of approximately 100 feet and tooled contraction joints at intervals equal to width of walks or maximum 5-foot intervals or as indicated on plans. Tool edges to rounded profile and finish as noted herein or shown on the drawings. Contractor may utilize sawed contraction joints. Pitch walks ¼-inches per foot for drainage unless otherwise indicated.

N. Ramps: Construct ramps similar to walks. Comply with applicable ADA Handbook, ANSI A117.1, and local and State codes, ordinances, and details including maximum allowable slope not to exceed 1 foot vertical in 12 foot horizontal, with maximum rise not to exceed 30-inches between level landings. Failure to meet this standard will require full removal and replacement.

O. Steps: Minimum 6-inches thick at intersection of treads and risers, reinforced as indicated. Slope treads ¼-inches to nosing, and tool nosings to uniform ½-inches radius. Finish as specified below.
P. Paving: Minimum 6-inches thick unless otherwise indicated. Provide expansion joints as indicated on the drawings, and contraction joints at a minimum 12-feet -0-inches EWW. Place concrete paving over compacted subgrade as specified in Division 2 Section “Earth Moving”. Provide minimum 1% slope for drainage unless otherwise indicated.

Q. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

R. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

S. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

T. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

U. Wet-Weather Placement: Do not begin to place concrete while rain, sleet, or snow is falling unless adequate protection is provided and, when required, acceptance of protection is obtained.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
C. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

2. Medium-to-Course-Textured Broom Finish: For use on roadways and streets only. Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3. Burlap Drag Finish: For use on roadways and streets only. Provide a coarse finish by dragging a clean, unused, section of burlap fabric longitudinally across pavement.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection and follow the recommendations of ACI 305R for hot-weather protection during curing.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch. Except in accessible path areas.
3. Surface: Gap below 10-foot-long, unlevelled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [Owner] will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 50 cu. yd. or fraction thereof of each concrete mix placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each type of concrete mix. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite strength test, but not less than one test for each day's pour of each type of concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of composite strength specimens.

5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.

6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 25 cu. yd., provide at least two tests for every 100 cu.yd., (one set for each 50 cu. yd.). One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results shall be reported in writing to Owner’s Representative, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner’s Representative, but will not be used as the sole basis for approval or rejection.

F. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Owner’s Representative. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Owner’s Representative when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313
CONCRETE PAVING JOINT SEALANTS

SECTION 321373 – CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Expansion and contraction joints within cement concrete pavement.
   2. Joints between cement concrete and buildings and structures.
   3. Surface preparation including primers.
   4. Joint backup material.

B. Related Sections include the following:
   1. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 REFERENCES

A. University of Colorado at Boulder Construction Standards and Specifications, latest edition.

B. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

C. Reference Standards: Comply with the requirements of the reference standards noted herein, except where more stringent requirements are described herein or otherwise required by the Contract Documents.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

C. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.
E. Warranty: As required by Division 1 – Warranty Section: Contractor agrees to repair or replace joint sealers (including labor, materials, and any necessary associated costs) which fail to perform as watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance or general durability; or appear to deteriorate in any other manner not clearly specified by submitted manufacturer’s data as an inherent quality of material for exposure indicated. Provide warranty signed by Installer and Contractor.

1.5 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Work under this section shall be subject to all applicable provisions of federal, state and local rules and regulations.

B. Applicator: Company specializing in application of sealants with five (5) years minimum experience and be acceptable to manufacturer. Manufacturer’s field representative shall visit site and make suggestions.

C. Adhesion Tests: Prior to any sealant application, perform adhesion tests as directed by sealant manufacturer’s technical representative.

D. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Install sealant materials in strict accordance with all safety and weather conditions recommended by manufacturer, product literature, or Material Safety Data Sheets. Do not proceed with installation of sealants under adverse weather conditions, or when temperatures are below or above manufacturer’s recommended limitations for installation. Proceed only when forecasted weather conditions are favorable for proper cure and development of high-early bond strength. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in lower third of manufacturer’s recommended installation temperature range.
PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As indicated by Owner’s designations

2.2 JOINT SEALANTS

A. Single-component formulation complying with ASTM D 6690 or D1190.

1. Refer to CDOT Standard Specification, Section 705.01 and 705.09 for joint and crack sealant material requirements.

2. Refer to CDOT Standard Specification, Section 412.18 for joint and crack sealant installation requirements.

2.3 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.4 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from manufacturers recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
   B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 JOINT DESIGN
   A. Sealant depth is measured at the center (thin) section of sealant bead.
   B. Install sealants to depths and widths as recommended by sealant manufacturer and as shown on the drawings. Also, conform to the following general limitations if not in conflict with sealant manufacturer’s recommendations.
      1. For sidewalks, pavements and similar joints subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, but neither more than 5/8 inch deep nor less than 3/8 inch deep.
      2. For normal moving joints not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 5/8 inch deep nor less than ¼ inch deep.
      3. Depth of sealant must not exceed width of joint.
      4. Sealant joints shall not be less than ¼ inch in width and ¼ inch in depth.
      5. Sealant joints shall not exceed 2 inches in width in a single application.

3.4 SURFACE PREPARATION
   A. Preparation work shall result in clean surfaces in all areas where sealant is to be adhered. Such surfaces shall be free of any old sealant, contaminants and impurities which are deleterious to bonding or adhesion of primers or sealant.
   B. Clean ferrous metals of all rust, mill scale and coatings by wire brush or grinding. Any equipment used to remove rust shall be free of oil contaminants.
   C. Wire brush masonry joint surfaces, then blow clean with oil free compressed air.
   D. Apply primer per manufacturer’s recommendations. Allow primer to dry prior to applying sealant.
   E. Do not caulk joints until they are clean, dry, and free of dust, loose mortar, old sealant, foreign matter or other bond inhibiting materials, and in compliance with requirements of manufacturer of materials, details shown on drawings, and specific requirements of other sections of specifications.
3.5 JOINT BACKING

A. Use joint backing to control depth of joint to specified thickness.

B. Select joint backing size to allow for 25% compression of backing when inserted into joint.

C. Where shown on drawings where depth of joint will not permit use of joint backing, or wherever recommended by sealant manufacturer, install bond-breaker tape to prevent three-sided adhesion.

D. Do not leave voids or gaps between ends of joint backing units.

3.6 APPLICATION/INSTALLATION OF JOINT SEALANT

A. Apply sealants neatly, in a good and workmanlike manner which meets following minimum requirements or standards. Specific instructions of manufacturer must also be followed.

B. Apply sealant using a gun with proper size nozzles. Use sufficient pressure to fill all voids and joints solid to backup material, with complete wetting of all joint bond surfaces.

C. Applied sealant shall form a full, smooth, uniform bead, free of ridges, wrinkles, sags, air pockets and embedded impurities.

D. After joint has been completely filled with sealant, neatly tool joint sealant to eliminate air pockets or voids, and to provide a smooth, slightly concave, neat appearing finish, with sealant surface slightly below adjoining surfaces. Wetting of finished surface will not be allowed.

E. Where horizontal joints are located between a horizontal surface and vertical surface, fill joint to form a slight cove, so joint will not trap moisture and dirt.

F. Protect adjacent surfaces and systems from sealant material. Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

G. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

H. Tooling of Non-Sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.

2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

I. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
J. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.7 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.8 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

3.9 JOB SITE CLEAN-UP

A. Sealant applicator must remove all excess materials from job site.

B. Leave all surrounding areas where joint sealant has been applied free of excess sealant, debris and foreign substances.

END OF SECTION 32 1373
SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the contract, including General and Supplementary Conditions, and Division 1 specification sections apply, to this Section.

1.2 SUMMARY

A. This Section includes the following: Furnish and install all painted lines, directional arrows, handicapped symbols, or similar markings on paved surfaces, as shown on the drawings or specified herein, as required by jurisdiction having authority, and as required to complete the work.

B. Related Work:

1. Division 32 Section “Asphaltic Paving” for materials, installation and minimum requirements.
2. Division 32 Section “Concrete Paving” for materials, installation and minimum requirements.

1.3 REFERENCES

A. Reference Standards: Comply with the requirements of the reference standards noted herein, except where more stringent requirements are described herein or otherwise required by the Contract Documents.


C. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.


1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s published descriptive literature and complete specifications for products specified herein.

1.5 QUALITY ASSURANCE

A. Qualifications: Pavement marking applicator shall be regularly engaged in this type of work, and shall provide adequate, experienced manpower and proper equipment to complete the work.
B. Regulatory Requirements: Comply with applicable provisions of Colorado State Department of Highways Specification Sections 627, 708, and 713.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Deliver materials in manufacturer’s original, unopened containers, with labels intact and legible.

1.7 PROJECT CONDITIONS

A. Environmental Requirements: Do not apply pavement marking when ambient air and pavement surface temperature is below 40°F for paint and below 55°F for epoxy and thermoplastic marking materials, or when moisture in any form is present on the pavement surface.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lane Marking Paint:

1. Opaque White: Matching Federal standard 585 for white paint and having the daylight directional reflectance specified in FS TT-P-115f, Type I.

2. Yellow: Match color chip No. 13538 of federal Standard 595 A with yellow color within the green and red tolerance limits when compared with the latest Highway Yellow Color Tolerance Chart, PR Color No. 1, U.S. Department of transportation, federal Highway Administration.

B. In-Laid Thermo-Plastic Markings:

1. Provide “Cata-Therm” by Cataphote, Inc., 1-800-221-2474, white reflective color, or approved substitute alkyd-based thermo-plastic material complying with AASHTO M249.

2. Provide drop-in glass beads which are skid-resistant and which comply with the City of Boulder standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.
3.2 PREPARATION

A. Surface Preparation: Allow fresh pavement surfaces to weather at least 30 days prior to application of traffic marking paint.

3.3 APPLICATION

A. Apply with mechanical equipment to produce a wet film thickness not less than 0.015” and 4” line widths unless otherwise required.

B. Handicap Parking:
   1. Standard space 8.5 with the ADA stencil (International symbol for handicap parking) centered in the stall. Stall shall be painted with a 5’x4’ blue background with white stencil centered within the background. Blue background shall be bordered with 3” white traffic paint. Stencil top shall face the front of the parking stall. Color pallet shall be traffic White and traffic blue paint.
   2. Curbing shall not be painted.

C. In-Laid Thermo-Plastic Markings:
   1. Provide for all crosswalks and stop bars.
   2. Saw or grind grooves in pavement for application of thermo-plastic material.
   3. Prime substrate as required by manufacturer.
   4. Install in accordance with manufacture’s instructions. Apply in 250 to 400 mil thickness. Apply such that cooled material is flush with or slightly above groove lip.
   7. Handicap Parking: Applications shall be white stencil on Blue 40”x40” square (centered in the stall) with 3” painted white border.
   8. Glass Beads: Drop into thermo-plastic material immediately after application.
1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Additional information concerning storm sewer systems may be found on the civil drawings. In case of conflict between the drawings and the information specified herein, the more stringent requirements shall govern.

1.2 REFERENCES
C. Reference Standards: Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.3 SUMMARY
A. This Section includes gravity-flow, and force-main storm utility drainage piping outside the building, with the following components:
   1. Drains and inlets.
   2. Precast manholes.
B. Related Sections include the following:
   1. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.
   2. Division 03 Section “Miscellaneous Cast-in-Place Concrete” for concrete structures.
   3. Division 31 Section “Earth Moving” for Site Grading.
   4. Division 31 Section “Temporary Erosion and Sedimentation Control” for erosion and sedimentation control measures.
C. Permits and Fees:
   1. Obtain and pay for all permits required for the work of this section.
   2. Pay all fees for inspections by local authorities and utility agency for work specified in this section.
D. Existing Utilities
1. It shall be the Contractor’s responsibility to excavate and verify the location (depth, horizontal alignment, etc.) of all existing utilities that may affect construction of the proposed storm utility drainage piping line. All exploratory excavations shall occur far enough in advance to permit any necessary relocation to be made with minimum delay and to verify existing vertical and horizontal location to determine alignment for the proposed storm utility drainage piping line. All costs incurred by the Contractor in making exploratory excavations shall be considered to be included in the unit price bid for construction of each section of storm utility drainage piping line or the associated structures.

E. All standard details and specifications of the utility agency shall apply as noted on the construction permit and as required by the agency.

1.4 DEFINITIONS

A. HDPE: High Density Polyethylene Pipe.
B. PVC: Polyvinyl Chloride Plastic Pipe.
C. RCP: Reinforced Concrete Pipe.
D. RCBC: Reinforced Concrete Box culvert.
E. CMP: Corrugated Metal Pipe.

1.5 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water (30 kPa). Pipe joints shall be watertight with gasketed joint.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Cleanouts, inlets and area drains.
   2. Manholes.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments for the following:
   1. Precast concrete manholes and other structures, including frames, covers and grates.
   2. Catch Basins and Storm Water Inlets. Include plans elevations, sections, details and frames, covers and grates.
C. Field Quality-Control Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.7 DELIVERY, STORAGE AND HANDLING

A. Do not store plastic inlets, pipe, and fittings in direct sunlight.
B. Protect pipe, pipe fittings, and seals from dirt and damage.
C. Handle manholes according to manufacturer’s written rigging instructions.
D. Handle catch basins and storm water inlets according to manufacturer’s written rigging instructions.
E. Deliver piping in manufacture’s original bundles, securely strapped, and with protective blocking as required. Label or tag each bundle with type, size and quantity of material.
F. Exercise care to prevent damage to materials during loading, transportation and unloading. Do not drop pipe or fittings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONCRETE PIPE AND FITTINGS
A. RCP Sewer Pipe and Fittings: According to the following:
   3. ASTM C 76 and ASTM C 506 and ASTM C 507 for circular, arch, and vertical and horizontal elliptical pipe, respectively. Pipe shall be Class III, Wall B, unless otherwise noted.
   5. Reinforced concrete box sections shall comply with ASTM C789.
   6. Locations: Reinforced concrete pipe may be used in all locations provided the pipe meets loading criteria.
   7. Acceptance shall be on the basis of plant load-bearing tests, material tests, and inspection of manufactured pipe for visible defects and imperfections as defined in ASTM C76. Conduct three (3) edge bearing test for load to produce a 0.01 inch crack. Conduct tests on 2 percent of the number of each size of pipe furnished for the project.
   8. Concrete shall have a minimum compressive strength of 4000 psi.

2.3 MANHOLES
A. Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete with a 28-day compression strength of not less than 4000 psi, of depth indicated, with provision for sealant joints. For drop manhole, see detail.
1. Diameter: As shown on drawings (48 inches (1200 mm) minimum, unless otherwise indicated).
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch (150-mm) minimum thickness for floor slab and the minimum thickness as noted on plans for walls and base riser section.
4. Riser Sections: 4-inch (100-mm) minimum thickness or as noted on the plans and the lengths to provide depth indicated.
5. Top Section: Eccentric-cone type unless flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.

B. Manhole Joint Sealant: All joints in the manhole barrel, cone and/or flat top sections including the joint between the cast-in-place base slab and the bottom barrel section shall be sealed with a preformed, flexible plastic gasket conforming to the following requirements:

2. The plastic sealing compound shall be packaged in extruded preformed rope-like shape of proper size to completely fill the joint when fully compressed. The material shall be protected by a suitable, removable, two-piece wrapper so that one wrapper may be removed as the compound is applied to the joint surface without disturbing the other wrapper, which remains attached to the compound for protection. The sealing compound shall be impermeable to water, have high immediate bonding strength to the primed concrete surface, and shall maintain permanent plasticity, resistance to water, acids, and alkalies.
3. All surfaces of the tongue and groove joint of the manhole barrel shall be primed with an approved priming compound prior to the installation of the sealing compound. The application of the priming compound and the sealing compound shall be accomplished in strict conformance with the manufacturer’s instructions, as to the method of application, quantity of material, the grade of the materials, and the application temperatures.
4. All lifting holes shall be sealed with the plastic sealing compound.

C. Steps: Steps shall be copolymer polypropylene coated steel steps Model PS2PF, as manufactured by M.A. Industries or approved equal.

D. Manhole Grade Rings: Reinforced-concrete rings, 6-inch to 9-inch total thickness, to match diameter of manhole frame and cover.

F. Manhole Frames and Covers: Ring and cover shall have a combined weight greater than 400 lbs shall be machined to fit securely with non-rocking cover, and shall be hot-dipped in asphalt. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER – DRAINS TO CREEK."

1. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.
2. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint or hot dipped asphalt; 10-mil (0.26-mm) minimum thickness applied to all surfaces, unless otherwise indicated.
3. Manholes located within the 100-year floodplain, or in a location where runoff may accumulate and pond, shall be installed with a bolting-type cover, to prevent loss of the
cover. The manhole ring shall be bolted to the manhole cone to prevent possible damage due to surcharge.

2.4 STORM WATER INLETS
   A. Inlets shall be constructed of reinforced concrete and shall conform to the dimensions and specifications as shown on the drawings. Inlet steps shall be built into and thoroughly anchored to the walls at the time of inlet construction. These steps shall conform to the requirements for manhole steps of these specifications.
   B. Pre-cast Concrete Units: ASTM C478 and C789, wall “B”, wall thickness of 1/12 of internal diameter. Cast steps into units.
   C. Frames and Gratings: Gray cast iron, ASTM A48, Class 30 B, fabricated for a minimum HS20 loading. Use Clean Water Act labeling on manholes and grates. All type C and D storm inlets shall be pedestrian safe and ADA compliant. No slots shall be greater than ½-inch in one direction and no holes shall be greater than ½-inch across.
   D. Type R and Type 13 inlets, see CDOT M+S Standard drawings.

PART 3 - EXECUTION

3.1 EARTHWORK
   A. Site excavation and filling are specified in Division 31 Section “Earth Moving.”
   B. Excavation and backfilling for utilities are specified in Division 31 Section “Trenching and Backfilling.”

3.2 PREPARATION
   A. Piping: Prior to installation, verify that insides of pipe and pipe joints are clean and free of dirt, mud, oil, shavings from cutting, or other deleterious materials.

3.3 PIPING INSTALLATION
   A. General Locations and Arrangements: Drawing plans and details indicate location and arrangement of underground storm utility drainage piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer’s written instructions.
   B. General:
      1. Use only undamaged material.
      2. Lay pipe on firm bedding with full length of barrel fully supported. Maintain straight lines and uniform grades between invert elevations shown. Inside of pipe shall be smooth and clean.
      3. Begin all pipe installation at downstream end of pipe run, with lower segment of pipe in contact with specified bedding. Place bell or groove ends facing upstream.
4. Plug ends temporarily during installation, until connections are made to adjoining pipe or to manholes or inlet structures.
5. Trench excavation and placement and compaction of bedding and backfill are specified in Division 31 Section “Trenching and Backfilling.”

C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer’s written instructions for use of lubricants, cements, and other installation requirements. Plug all lifting holes in pipe with approved rubber plug or grout.

D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

F. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

G. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow, at slopes indicated on plan.
2. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA’s “Concrete Pipe installation Manual.”

3.4 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Construct cast-in-place manholes as indicated.

D. Manholes:

1. Construct manholes in accordance with drawings and applicable agency having jurisdiction standards. Carry pipe through manhole with split pipe. Extend cast-in-place concrete manhole base at least 8 inches below pipe barrel.
2. Slope floor of manhole from centerline of pipe to maximum of 2 inches above top of pipe at face of manhole. Shape invert when manhole base is poured to conform exactly to lower half of pipe.
3. Form or shape inverts smooth and clean, with no obstructions. Allow insertion of an expandable plug in pipe. Construct side branches with radii as large as possible to connect to main invert.
4. Extend concrete base ring minimum 3 inches above top of pipe.
5. Place future extension of pipe from manholes in manhole base. Shape invert with pipe extended to outside face of manhole base and terminated with bell of pipe as close as practical to manhole base.
6. Do not place precast manhole sections on manhole base for two days minimum after placement of concrete base. Thoroughly clean top of formed concrete base ring prior to placing manhole barrel sections.
7. Place a complete and continuous roll of sealant in groove or keyway of concrete base ring in sufficient quantity that when precast manhole barrel is placed there will be no voids. Join each succeeding precast manhole barrel in similar manner. Install sealant in groove side of tongue and groove joints.
8. Trim away all excess material and repair all lifting holes.

E. Manhole Rings and Covers:
1. Set tops of frames and covers 1/8 inch below finished surface of manholes that occur in pavements. Set tops 1 inch (25 mm) above finished surface elsewhere, unless otherwise indicated.
2. Where finished surface will be completed after manhole construction, set top of cone where a maximum of two courses of brick will be required to adjust ring and cover to final grade. Final elevations of lid will be adjusted with bricks, mortar or precast concrete rings with a minimum of 6 inches and a maximum of 18 inches of adjustment.

3.5 INLETS, OUTLETS AND CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.
1. Cast-in-place or precast concrete in accordance with drawings and applicable agency having jurisdiction standards. Comply with applicable requirements of Division 03 Section “Miscellaneous Cast-in-Place Concrete.”
2. Construct inverts of pipe or concrete smoothed inverts same size as pipe up to centerline of pipe. Form perimeter bench as indicated.
3. Embed steel angles or other accessories as indicated or required to anchor and support frames, grates, or covers.

B. Frames, Grates, Covers and Steps: Install accurately to placement dimensions shown on drawings. Anchor castings in place and set in adjustment mortar to assure a firm foundation.

C. Connection to Existing Structures:
1. Cut and patch or rebuild existing manhole, catch basins, or other drainage structures as required to receive new drain lines.
2. Core drill openings to receive new pipe. Chip existing bench to provide sufficient thickness for mortar bed to form new invert.
3. Seal around new pipe penetration with expandable waterstop sealant, completely filling space between pipe and cut opening to provide a watertight repair.

3.6 CLOSING ABANDONED STORM UTILITY DRAINAGE PIPING SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use one of procedures listed below:
1. Fill pipe with stone or gravel flowfill.
2. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
3. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36-inches below final grade. Fill to within 12-inches of top with stone, gravel or sand. Fill to top with concrete.

C. Backfill to grade according to Division 31, Section “Earth Moving” and Section “Trenching and Backfilling.”

3.7 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section “Earth Moving.” Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Utility Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Option: Test plastic piping according to ASTM F 1417.
   b. Option: Test concrete piping according to ASTM C924 (ASTM C 924M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.9 CLEANING

A. Clean interior of piping, inlets and manholes of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334100