

**City of Casper
Standard Specifications
for
Public Works Construction
and
Infrastructure Improvements**

**City of Casper
Casper, Wyoming**

January, 2006

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Standard Specifications
for
Public Works Construction
and
Infrastructure Improvements**

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2018 AMENDED SECTION 401,
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NO LONGER USED BY THE CITY OF CASPER

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DIVISION 100

SECTION 101

GENERAL CONSTRUCTION REQUIREMENTS

101.01 Description.

To establish uniform requirements for construction of water distribution facilities, sanitary sewerage collection facilities, storm sewer collection systems, streets, and associated appurtenances which will enable the construction to be performed in accordance with Local, State, and Federal laws.

101.02 Definitions.

A. For the purposes of these specifications, the words and phrases set out in the following articles shall have the meanings as follows:

1. “City” means the governing body of the city of Casper, Wyoming.
2. “Contractor” means the individual, partnership, firm, or corporation contracting with the developer or the City which will be performing the work, or which will be performing the construction activities.
3. “Developer” means partnership, firm, or corporation developing property where construction will be performed.
4. “Engineer” means the consultant or project Engineer.
5. “Owner” means the individual, partnership, firm or corporation being the owner of record of property where construction will be performed.
6. “Underground facility” means any item of personal or public property buried or placed below ground for use in connection with the storage or conveyance of electronic, water, sewage, telephonic or telegraphic communications, cabletelevision, electric energy, oil, gas, hazardous liquids, or other substances and including, but not limited to pipes, sewers, water, stormwater, conduits, cables, valves, lines, wires, manholes, and attachments.

B. The following abbreviations shall have the designated meanings:

1. “APWA” means the American Public Works Association.
2. “ASTM” means the American Society for Testing and Materials.
3. “AWWA” means the American Water Works Association.

4. "AASHTO" means the American Association of State Highway & Transportation Officials.
- C. Reference to a specific specification, i.e., AWWA C900, means the latest Edition of that specification.

101.03 Scheduling and Construction Progress.

- A. Prior to the start of any work, the Contractor shall submit in writing to the Engineer for review, a progress schedule that shall be followed as closely as possible. Progress scheduling using critical path method is approved and encouraged. Once work has started on a street, it must be pursued continuously until all work on that street is finished.
 1. The Contractor shall schedule a preconstruction conference prior to the start of work. Persons attending shall include representatives of the Contractor, subcontractors, owner, developer, Engineer, and affected utilities.
- B. Each successive phase of work will follow the preceding phase as closely as possible so that the time any one street is under construction is kept to a minimum.
- C. In the event that the work is not being accomplished expeditiously or in accordance with the time period set forth in the progress schedule, or if the work on an excavation has ceased or is abandoned without due cause, the Engineer may give written notice to the Contractor and/or the surety company for the project.

101.04 Notification of Landowners, Residents, and Businesses

- A. At least one (1) week prior to beginning construction operations Contractor shall notify in writing, all those directly affected by the Work, including the Fire, Ambulance, Police Departments, and the Engineer's Office. The notification shall include the following as a minimum:
 1. Name, address, telephone number, and contact person for Developer, Developer's Contractor, Owner, and Engineer.
 2. A brief description of the proposed Work.
 3. Name and telephone number of Contractor's person to contact in emergency.
 4. A map showing the Work area, the traffic control plan, and the planned access to be provided to the affected properties. The map should also show the property or business owners' access during construction, and access in case of

an emergency for fire, ambulance, police, or other emergency service agency vehicles.

5. A schedule for start up and completion of the Work. Schedules shall be updated as needed as the work progresses.
6. Contractor shall notify property owner and occupant 24 hours in advance of any disruption of service or access.

101.05 Available Maintenance Personnel

The Contractor shall have personnel available to maintain the Work as required, 24 hours per day every day. Accordingly, the Contractor shall furnish the City, the Owner, the Engineer, and the Casper Police Dispatcher with the names, addresses, and telephone numbers of local employees or representatives who will be available to maintain the Contractor's work during non-working periods, evenings, nights, weekends, and holidays.

101.06 Utility Locates.

- A. It is the responsibility of the Contractor to obtain locates for buried facilities within the project area prior to the start of work as necessary and as required by law. The Contractor is responsible for any damage to buried utilities or damage or injury to persons or property resulting from Contractor's work in the vicinity of the utilities.

It is the responsibility of the Contractor to provide advance notice to all utility notification centers serving that area. The Contractor shall request the notification center to provide the nature, location, and elevation of the utility at each location and at whatever interval is necessary for the work. If the utility company cannot or will not provide the information, the Contractor shall obtain the information by whatever means are necessary. For each location that the utility is exposed, the Contractor shall locate the utility by tying it both horizontally and vertically by coordinates, to the datum established by the City.

- B. At all utility crossings the Contractor shall locate the utility at a minimum of one point directly over the proposed line or appurtenance. When existing utilities that parallel the proposed line or appurtenance are exposed by excavation, the Contractor shall locate the utility by tying it both horizontally and vertically to the datum and include the information on the record drawings. At a minimum, the utility shall be tied horizontally and vertically at 300-foot (90 m) intervals.
- C. If during the field location of the utilities, additional unforeseen utilities are discovered, the Contractor shall immediately notify the Engineer and proceed in accordance with approval of the Engineer. The utility must be located by the Contractor as specified above and include the information on the record drawings.

- D. The Contractor must protect all existing utilities and improvements, public or private, located on the right-of-way, and other work areas, during the entire period of his work. Special care must be taken in backfilling and compacting under and around such improvements. Any breakage or damage to underground facilities caused by trenching, backfilling, resurfacing, or any other activity associated with the work shall be the responsibility of the Contractor.
- E. Whenever utility mains or services are crossed, the utility owner shall be notified and the crossing shall be constructed in accordance with the utility owner's requirements.
- F. Before the Contractor begins his grading operations, he shall confer with the owners of any underground or overhead utilities which may be in or in close proximity to the grading areas, and shall arrange for the necessary disconnection of these utilities in accordance with the regulations of the utility companies concerned. The Contractor shall take such measures as the Engineer may direct in protecting these utilities properly throughout the period his grading operations are in progress. The party or parties owning or operating overhead or underground utilities shall perform the actual work of moving, repairing, reconditioning, or revising the utilities, except as otherwise specified in this Section. Whenever and wherever such operations are undertaken by the owners of utilities, the Contractor shall cooperate to the extent that ample protection of their work will be provided so that the entire work as contemplated may be expedited to the best interests of all concerned, as judged by the Engineer.
- G. Protect and safeguard existing service lines and utilities structures, the locations of which have been made known to the Contractor by the owners of the utilities or by others, prior to excavation or construction of fills or embankments, from damage during grading operations. Any damage to such lines or structures shall be repaired at the Contractor's expense. The above provisions are applicable to all service lines or utilities structures, all or any portion of which protrude above the original ground or street surfaces, or lie beneath such surfaces in any grading area or any other area upon which the Contractor has encroached.

101.07 Protection of Existing Buildings and Structures.

The Contractor shall guard against, and be responsible for, any movement, settlement, or collapse of adjacent buildings, sidewalks, structures, and underground or above ground utilities. The Contractor shall repair damage done to the owner's property or any other property, on or off the premises, by reason of his operations. The Contractor shall adequately brace walls during backfilling and compacting operations.

101.08 Construction Stakes – Alignment and Grades.

- A. All work shall be constructed in accordance with lines and grades shown on the drawings and as designated by the Engineer. These lines and grades may be modified by the Engineer as provided in the General Conditions.
- B. The Contractor shall provide experienced personnel, materials, and equipment necessary to complete all survey, layout, and measurement work. The Contractor shall keep the Engineer informed a reasonable time in advance, of the times and places he wishes to do work so that initial control points may be designated.

101.09 Restoration of Street Surface, Street Signs, Curbs, Driveways, Sidewalks, Irrigation and Landscaping.

- A. Wherever existing improvements are removed, damaged or otherwise disturbed by Contractor's activities, Contractor shall replace or repair the improvements to conditions equal to or better than the condition prior to the start of work. Any crushed rock, sod, or natural vegetation disturbed by the Contractor shall be replaced, rebuilt or restored to conditions equal to or better than the condition prior to the start of work.

101.10 Temporary Utilities, Public Access and Safety.

- A. Contractor shall provide temporary water and sewer service to properties when permanent facilities will be out of service for eight (8) hours or longer, or when other circumstances make it necessary. Where service cannot be interrupted, such as sewer mains, Contractor shall provide plant and equipment to pump around the sections which are out of service.
- B. Where the Engineer deems necessary, the Contractor shall provide access wherever possible to public and private property to prevent serious inconvenience to pedestrian and vehicular traffic. This shall not be construed to require the Contractor to provide such access at the times and locations where it will interfere with his construction progress. The Contractor shall furnish, place, and maintain sufficient flags, flares, barricades, signs, etc., along the location of his work in accordance with the Federal Highway Administration, "Manual on Uniform Traffic Control Devices." Flag persons shall be utilized if necessary to maintain safe traffic flow.

101.11 Erosion and Sediment Control

Erosion and sediment control shall be performed in accordance with Casper City Code Chapter 12.20 – Erosion and Sediment Control.

101.12 City Permits

All necessary permits shall be obtained prior to the beginning of any construction project. Those permits may include: City of Casper/WDEQ Permit to Construct, Excavation Permits, Traffic Control Permits, Bonds, and Erosion and Sediment Control Permit, as well as any other appropriate permits required for the project by the City.

101.13 Punchlist and Final Closeout

A. Initial City Punchlist

1. The Contractor, Owner, Engineer, and City personnel will conduct an initial walkthrough and develop a list of deficiencies that will be presented to the Contractor by the Engineer.
2. The Contractor, Owner, and Engineer will conduct a walkthrough identifying items to be corrected. A final punchlist will be developed by the Contractor and Engineer. The punchlist will contain dates for completion of the various identified items.
3. All items on the list will be completed to the satisfaction of the City prior to acceptance of the project and start of the one-year warranty period.

101.14 Submittals

The Contractor shall submit for approval by the Engineer a minimum of five (5) copies of data required by specific sections of this specification.

101.15 Workmanship and Cleanup.

- A. All debris and rubbish caused by the operations of the Contractor shall be removed, and the areas occupied during his operations shall be left in a neat and presentable condition satisfactory to the Engineer. Construction cleanup and all backfill operations shall immediately follow installation of underground facilities. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc. During construction, all existing gutters, storm drains, runoff channels, etc. shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.
- B. Excess, unsuitable, and waste materials from the project (including that from trench excavation, pavement removal, curbwalk removal, and grading operations), shall be suitably disposed of, offsite, by Contractor.

- C. Excess material resulting from parkway and shoulder finishing and other final operations shall not be permitted to accumulate on the pavement surface and shall be removed concurrently with the finishing operations. Care shall be taken to prevent the entrance of this material into drainage structures or other waterways during the construction period. It shall be the responsibility of the Contractor to properly dispose of all excess material.

101.16 Design Mixes, Testing and Quality Assurance.

The testing requirements and cost responsibilities of design mixes, testing requirements, and quality assurance testing are listed in each specific section of these specifications.

Unless specified by the contract documents, or addressed specifically within these Standard Specifications, the Owner will be responsible for moisture/density/compaction testing only. If the initial moisture/density/compaction test fails to meet the minimum standards as established by these specifications, the Contractor shall pay for any and all additional tests until a moisture/density/compaction test meeting the minimum standards is obtained.

DIVISION 200

SECTION 201

ROADWAY EARTHWORK

201.01 Description.

This section covers work for all excavations, embankments, grading, parkway finishing, and incidental excavation items for street earthwork.

201.02 Definitions.

- A. Unclassified Excavation Above Subgrade. Unclassified excavation above subgrade is defined as any material excavated above the subgrade elevation within the street right-of-way which is placed in fill or disposed of as directed by the Engineer, and any material taken from borrow pits and deposited as embankments or fill within the streets above the proposed subgrade elevation.
- B. Relative Compaction. Relative compaction is defined as the ratio, in percent, of the as-compacted filled dry density to the laboratory maximum density. The laboratory maximum dry density is defined in accordance with ASTM D4253 and D4254, Method C. Corrections for oversize material will be applied as determined by the Engineer.
- C. Optimum Moisture Content (OMC). Optimum moisture content is defined by ASTM D698.
- D. Unclassified Excavation Below Subgrade. Unclassified excavation below subgrade is defined as any material excavated below the subgrade elevation within the street paving width which is placed in fill or disposed of, as directed by the engineer, and any material taken from borrow pits and deposited as embankment or fill within the street paving width below the proposed subgrade elevation.
- E. Imported Borrow Excavation. Imported borrow excavation shall consist of excavation made from borrow areas inside or outside the project limits, and outside the normal grading limits for completion of embankments.

201.03 Excavation to Grade.

- A. Excavation shall be made to grade dimensions and cross-sections as shown on the plans or as directed by the engineer. The top of the finished subgrade shall be of such smoothness that when tested with a ten foot (10') (3m) straight edge it shall not show any deviation in

excess of one-half inch (1/2") (12.5mm) from true grade as established by grade hubs or

pins. Any deviations in excess of these amounts shall be corrected by loosening, adding, or removing materials, reshaping, and recompacting by wetting and rolling.

- B. Excavation shall be done in two (2) stages. The first stage shall consist of the removal of material down to the top of the subbase. The second stage shall consist of removing the material from the top of the subbase to the top of the subgrade. When the first stage of excavation has been completed, the material at subbase grade shall be examined and inspected by the engineer. If the material at proper grade and depth conforms to or exceeds the requirements of material for subbase course, as specified in Division 400, Section 401, and as determined by the Engineer, further excavation will not be required and the subbase course will be omitted. If suitable subbase material is not encountered, the excavation shall be completed until suitable material is encountered.
- C. When naturally existing subbase material is used, it shall be rolled, watered, and treated as specified in Division 400, Section 401 of these Specifications.

201.04 Subgrade Preparation.

- A. Subgrade material shall be defined as that soil or other natural existing material in the street which supports the pavement. In the case of flexible type pavement, the subgrade shall be that surface supporting the prepared subbase, base, and surface course.
- B. Excavation above subgrade shall be cut approximately one inch (1") (25mm) above subgrade and the subgrade shall be scarified six inches (6") (150mm) the moisture adjusted to within $\pm 2\%$ of optimum moisture content and compacted to at least 95% of maximum density as determined by ASTM D698. The compacted subgrade shall extend one foot (1') (.3m) beyond the outside edges of the pavement base course or from lip to lip of curbwalk gutter, if the latter is in place, and have a uniform density across the entire width of the street.
- C. Excavation below subgrade shall be performed where spongy, organic, or otherwise unsuitable material is encountered, which, in the opinion of the engineer, will not provide a suitable foundation for the subbase or base course, the unsuitable material shall be removed to the depth specified by the engineer and replaced with acceptable material. Replacement material shall be moisture conditioned and compacted to a minimum of 95% maximum density, as determined by ASTM D698 and a moisture content of $\pm 2\%$ of optimum.

201.05 Subgrade Protection.

During construction, subgrades and excavations shall be kept shaped and drained. Ditches and drains along the subgrade shall be maintained so as to drain effectively at all times. Where ruts occur in the subgrade, the subgrade shall be brought to grade, reshaped, and recompacted prior to

placing of subbase or base course. The storage or stockpiling of materials on the subgrade will not be permitted. No subbase course shall be laid until the subgrade has been checked, proofrolled, and approved by the Engineer. Under no circumstances shall subbase or base material be placed on a muddy subgrade.

201.06 Imported Borrow Excavation.

- A. Where fill is required for embankment, the fill shall be composed of clean earth, sand, or gravel, free from vegetable matter or other objectionable foreign material. The area to receive fill shall be stripped of all vegetation and other unsuitable material before fill placement is started. Slopes shall have surfaces broken up in such a manner that fill material will bond with existing surface as directed by the Engineer. The fill shall be placed in layers not to exceed six inches (6") (150mm) compacted thickness eight inches (8") (200mm) loose thickness. The material in each layer shall be moistened to within \pm 2% of optimum moisture content as directed by the Engineer and shall be rolled until at least 95% of maximum density as measured by ASTM D698. When borrow is required, it shall be taken from a source approved by the Engineer. Fill shall be defined as imported borrow excavation.

- B. All curbs shall be backfilled in the parkway (or shoulder) prior to laying any base course.

201.07 Parkway and Shoulder Finish.

Promptly after completion of curbwalk construction, the areas between the curbwalk and the property lines, shall be brought to a uniform, smooth grade, unless otherwise directed by the engineer. Hand raking may be required around trees and in areas where larger equipment cannot be used. Fill material placed in such areas shall be free from stones, sticks, or other materials which will be objectionable for seeding or sodding purposes. Backfill material shall be suitable for the growth of lawn grass. The backfill need not be compacted -- however, finished grade shall be left one inch (1") (25mm) high to allow for settlement. The Contractor shall maintain the parkway area until final acceptance.

201.08 Dust Control.

It shall be the responsibility of the Contractor to take such action as may be necessary to minimize pollution due to blowing dust. The normal method of dust control is spraying with water by means of a pressure water distributor. The Contractor shall provide on-site, at all times, a water truck to be used for dust abatement. If this method is used, care shall be taken to avoid development of mud holes and to avoid erosion. With the Engineer's approval, other methods of dust control may be utilized, such as hygroscopic materials. Such materials shall not be used if they may have a deleterious effect on future work to be accomplished on the surface to which they are applied, if they may harm vegetation with which they come in contact, if they may contribute to corrosion of metals, or if they are dangerous or irritating to humans or to animals.

201.09 Subgrade Proofrolling.

- A. Before the placing of any type of hard surfacing on the finished subgrade, such subgrade shall be proofrolled with at least one pass of coverage for its full width and length with a self-propelled pneumatic roller. Ground contact pressure of all tires shall be 85-90 psi (585-621 kPa). At the discretion of the Engineer, the specified ground pressure may be lowered. When the proofrolling shows an area to be unstable, such area shall be brought to satisfactory stability by additional compaction, reworking, or removal of unsuitable material and replacement with acceptable material.

- B. Schedules for Proofrolling.
 - 1. All utilities, including laterals or service pipes located under the street or the curb, gutter, and sidewalk, must be in place before the proofrolling operation is performed.
 - 2. Proofrolling shall not take place more than 24 hours prior to the placing of the concrete for the curb, gutter, and sidewalk section, or the hot mix asphalt street section.
 - 3. The Owner, City representatives, and Engineer must be notified, and approval of the base given, prior to the installation of any portion of the street section including curb, gutter, and sidewalk.

DIVISION 200

SECTION 202

CRACK SEALING

202.01 Description

The work consists of preparing and sealing random cracks in asphaltic concrete paving with hot-poured, elastic-type crack sealant.

202.02 Materials

The sealant shall conform to AASHTO M 173. The sealant manufacturer shall provide a written certification stating the quantity of sealant and that the sealant conforms to AASHTO M 173.

202.03 Preparation of Cracks.

- A. Cracks less than three-eighths inch (3/8") (9mm) wide. For cracks less than three-eighths inch (3/8") (9mm) width, the crack shall be widened using a router to form a sealant reservoir which is one-half inch (1/2") (12mm) wide and three-quarters to one-inch (3/4" to 1") (20-25mm) deep.
 1. The routed crack shall then be cleaned of dust, dirt, and other loose deleterious materials with oil-free compressed air. Cracks shall be dried with a compressed air heat lance immediately in advance of sealing. The heated air from the heat lance shall have a minimum temperature of 2800°F (1550°C), and a minimum velocity of 2800 feet per second (850m/s). Direct flame driers shall not be used. Pavement shall not be oxidized or burned with the heat lance. The prepared cracks shall be inspected by the Engineer prior to sealing.
- B. Cracks less than one-quarter inch (1/4") (6mm). Cracks less than one-quarter inch wide shall be sealed during the seal coating.
- C. Cracks wider than three-eighths inch (3/8") (9mm) wide. Cracks wider than three-eighths inch (3/8") (9mm) in width shall be cleaned for the entire crack depth using sandblasting, brushing, and airblowing techniques as required to provide a crack free from all debris, dust, loose material, and moisture.
 1. The routed crack shall then be cleaned of dust, dirt, and other loose deleterious materials with oil-free compressed air. Gouging or plowing may be required to remove incompressibles deep in the crack. Cracks shall be dried with a compressed air heat lance immediately in advance of sealing. The heated air from the heat lance shall have a minimum temperature of 2800°F (1550°C), and

a minimum velocity of 2800 feet per second (850m/s). Direct flame driers shall not be used. Pavement shall not be oxidized or burned with the heat lance. The prepared cracks shall be inspected by the Engineer prior to sealing. The cleaned crack shall then be filled with sealant from the bottom up to surface level in a manner which does not result in sealant bridging or entrapped air pockets. With deep cracks, settlement of the sealant may occur, thus requiring application of a second layer of sealant material.

- D. Depressed surface cracks. For cracks which have a depressed surface on each side of the crack, the crack shall be overfilled to level with the pavement surface and then "squeegeed" to fill in the depressed area. The cracks shall be prepared as in paragraph B above.

202.04 Crack Sealing

A. Conditions

1. Crack sealing shall be done only when the weather conditions are dry, and in accordance with the sealant manufacturer's recommendations. Two copies of the sealant manufacturer's recommendations for preparation, handling, mixing, and application shall be furnished to the Engineer before beginning sealing.

B. Equipment

1. The equipment used for routing cracks shall produce a reservoir with vertical sides and a flat bottom. The pavement adjacent to the reservoir shall not show any signs of damage resulting from the routing operation. If the adjacent pavement is damaged, the Contractor shall alter the equipment and/or the procedure to eliminate the damage to the satisfaction of the Engineer.
2. The machine used to apply the sealant shall continuously maintain the recommended sealant application temperature. If the sealant temperature cannot be maintained while adding additional sealant, two sealing machines shall be used. The sealing machines shall be equipped with a positive-acting device to continuously agitate and mix the sealant during application.

C. Application Of Sealant

1. The sealant shall be applied to the crack from the bottom up. The sealant shall be recessed slightly below the pavement surface. Any excess material shall be smoothed tightly against the pavement surface.
2. The sealant shall not be tracked or pulled out during construction. Sealant damaged by tracking shall be replaced at the Contractor's expense.

***DIVISION 200**

SECTION 203

TOPSOIL, SEEDING AND LAWN RESTORATION SPECIFICATIONS

203.01 Description

The work covered in this article includes the furnishing of all materials, labor, tools and equipment to restore topsoil, seeding, and lawn restoration as described in the specifications.

203.02 Restoration of Lawn and Grassed Areas.

- A. Any sod which is disturbed during the project or its appurtenances shall be replaced with similar sod including necessary topsoil, by the Contractor.
- B. Top soil shall be replaced to a thickness equal to that removed up to a maximum of one foot (1') (300mm). No sod or seed shall be laid on less than four inches (4") (100mm) of topsoil. Topsoil shall be light friable loam containing a liberal amount of humus and shall be free from heavy clay, coarse sand, stones, plants, roots, sticks, and other foreign materials.
- C. Sod shall be rolled within 24 hours after its placement with a roller that leaves the sod smooth and the joints properly closed. The new sod shall be trimmed neatly to match old sod, curbs, and walks. In all sod areas, the Contractor shall be responsible for ensuring adequate moisture until the new sod has properly established itself.
- D. In other areas, the Contractor shall reseed as specified in the City's Standard Specifications.
 - 1. In general, Type 1 seeding shall be used in developed areas where the disturbed vegetation would not be classified as sod; Type 2 seeding shall be used in undeveloped areas having a "native" grass vegetation. After the trench has been backfilled as specified, the Contractor shall place four inches (4") inches (100mm) of topsoil over the trench area, prior to Type 1, seeding. Topsoil is not required with Type 2 seeding. The area to be seeded shall be made smooth and uniform and shall conform with the finished grade.
 - 2. The seedbed, if not loose, shall be loosened to a depth of from 1 to 2 inches (25-50mm) below finished grade. Seeds and fertilizers can be sown with standard agricultural drills, or other approved methods. Grass seeds may be sown broadcast or with a special seeder attachment on agricultural drills, but

shall not be covered with more than ½-inch (12mm) of soil, whether drilled or raked in. If not covered by the drill, all uncovered seed shall, immediately after sowing, be slightly raked or harrowed to cover the seed. No seed shall be broadcast during high wind.

3. Seeding shall not be done between November 15 and February 15, nor between July 1 and August 15, unless irrigated by sprinkler system. During other periods, the time of sowing shall be determined by the Engineer, whose decisions will be based on the moisture content of the soil and weather conditions.

203.03 Seed Specifications.

- A. Type 1 seed shall be applied at the rate of 75 pounds per acre (84 kilograms/hectare). The seed mixture shall not contain in excess of 0.5 percent weed, 0.5 percent crop seed, and 6.0 percent inert matter and shall meet the following specifications:

<u>Name of Seed*</u>	<u>Percentage Seed by Weight</u>	<u>Minimum Germination</u>
Park Kentucky Bluegrass	30%	80%
Kentucky Bluegrass	40%	75%
Perennial Ryegrass	30%	90%

All seed mixtures and seeding methods shall be submitted for approval.

***All seed shall be turf quality varieties.**

Grass seed mixtures under brand names may be acceptable if they approach the above specifications and if accepted by the City Engineer.

- B. Type 2 seed

1. Type 2 seed shall be as follows:

- (i) Streambank Wheatgrass - 8 lbs. pure live seed/acre (9 kg/hectare).
- (ii) Fairway Crested Wheatgrass - 8 lbs. pure live seed/acre (9 kg/hectare).
- (iii) Western Wheatgrass - 14 lbs. pure live seed/acre (16 kg/hectare).

203.04 Fertilization and Mulching

- A. Fertilizer shall be applied in the amount to result in forty (40) pounds (45 kg/hectare) of available nitrogen per acre. Straw or hay mulch shall be applied in the amount of two (2) tons per acre (4492 kg/hectare). Cellulose hydromulch

shall be applied according to manufacturer's recommendation.

203.05 WARRANTY

A. Weed control in planted areas shall be the responsibility of the contractor. Watering schedules of City- owned property shall be the responsibility of the contractor during the warranty period. Contractor shall coordinate water schedules with the City of Casper mowing operations.

DIVISION 200

SECTION 204

IRRIGATION STANDARD SPECIFICATIONS

204.01 Description.

Work in this section consists of all labor, materials, and equipment necessary to do all work and related items as shown on the drawings, specified herein or incidental to install the irrigation system required as indicated on the plans and includes, but not necessarily limited to: Lawn and shrub sprinkler system automatic controller and remote control valves, the proper execution of the work, including trenching, boring under driveways, walks, and curbs, installation of pipe sleeves, and backfilling.

204.02 Quality Assurance.

- A. For actual prosecution of the work, use only personnel who are skilled in the work required, familiar with recommended methods of installation, and thoroughly familiar with the requirements of this work. The Contractor shall have a minimum of 5 years experience in commercial or residential lawn irrigation installation.
- B. Provide at least one person who shall be present at all times during execution of this portion of the work, and who shall be thoroughly familiar with the type of materials being installed, and material manufacturer's recommended methods of installation, and who shall direct all work performed under this section.
- C. All work of this section and the installation of all lawns and all plant materials shall be performed by a single pre-approved Contractor .
- D. In addition to complying with all pertinent codes and regulations, comply with the latest rules of the National Electrical Code for all electrical work and materials.
- E. Where provisions of pertinent codes and standards conflict with the requirements of this section of these specifications, the more stringent provisions shall govern.

204.03 Utility Locates

Utility Locates shall be in accordance with Division 100, Section 101.06.

204.04 Submittals

- A. Before any irrigation system materials are delivered to the job site, submit to the Owner's Representative a complete list of all irrigation system materials proposed to be furnished and installed.
- B. Show manufacturer's name and catalog number for each item, furnish complete catalog cuts and technical data, and furnish the manufacturer's recommendations as to method of installation.
- C. Do not permit any irrigation system component to be brought onto the job site until City's Representative has approved it.

204.05 Product Handling

- A. Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installed work and materials of all other trades.
- B. In the event of damage, immediately make all repairs and replacements necessary to the approval of the City's Representative and at no additional cost to the City.

204.06 Materials

- A. Plastic Pipe.
 - 1. All mainlines and transmission lines shall be Schedule 40 PVC; laterals shall be Class 200 PVC. Plastic pipe shall be rigid unplasticized conforming to ASTM D-1784 and D-2241 standard specifications for PVC plastic pipe. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, deleterious wrinkles, and dents.
 - 2. All pipe shall be continuously and permanently marked with the following information:

Manufacturer's name or trademark, size, schedule and type of pipe, working pressure at 73°F (23°C), and National Sanitation Foundation (N.S.F.) approval.
- B. Risers.
 - 1. All stationary spray heads shall have risers of high density polyethylene plastic pipe ("funny pipe") with spiral barbed ell fittings. Minimum length of "funny pipe" shall be eighteen inches (18") (450mm).
 - 2. All rotor pop-up sprinklers shall have an adjustable pre-assembled double swing joint riser. Swing joints shall be Lasco or Spears Marlex ells MIPT x

FIPT or equal approved in advance by the City's Representative. Swing joints shall be twelve inches (12") (300mm) long and shall be threaded on both ends. The swing joint riser shall be of proper pipe size to match head threads.

C. Manual Valves.

1. All manual ball valves, sizes three-inch (3") (75mm) and smaller, shall be full ported ball valves with maximum working pressure of 175 psi (1200kPa) and 350 psi (2400kPa) hydrostatic test pressure.
2. All manual gate valves of four-inch (4") (100mm) size or larger shall be iron body, brass trimmed, double disc wedge type with integral taper seats and with non-rising stems, and shall be Mueller A-2360 resilient wedge gate valves with mechanical joints or equal accepted in advance by the City's Representative. All manual gate valves shall be 200 psi (1380kPa) rated.

D. Valve Boxes.

1. All remote control valves, manual control valves, zone shut-off valves, ball valves, or globe valves unless otherwise indicated, shall be installed in valve access box of proper size as required for easy access to the valve.
2. Valve boxes shall not be located within a playing field. Valve boxes shall be placed with a minimum of five feet (5') (1.5m) separation between each valve box.

E. Sprinkler Heads.

1. All heads of a particular type and for a particular function in the system shall be of the same manufacture and shall be marked with the manufacturer's name and identification, in such a position that they can be identified without being removed from the system.

F. Automatic Irrigation Controllers

1. Field controllers shall be model numbers and manufacturers as shown on the plans, or acceptable equal.
2. Field controllers shall be installed on approved concrete bases in accordance with the manufacturer's recommendations as shown on the drawings.
3. Field controllers shall be installed with manufacturer's lightning and surge protection.

4. Central controller shall be model number and manufacturers as shown on the plans, or acceptable equal. Central controller shall be located as shown on the drawings.
5. On site lockable disconnects or lockable fuse block and a 110 volt outlet shall be installed at each controller in a separate lockable water-tight enclosure.

G. Automatic Remote Control Valves.

1. All remote control valves shall be two-inch (2") (50mm) Toro 216 or two-inch (2") (50mm) Rainbird GB globe pattern. All valves shall be 24-volt, with epoxy-sealed solenoid coils and throttling stem. All splices shall be installed with 3M DBY and DBR types and all splices shall be made inside the valve box.

H. Control Cable.

1. All electric control and ground wire shall be irrigation control cable on approved equal, 14-gauge unless otherwise indicated on the drawings. All wiring to be used for connecting the automatic remote control valve to the automatic controllers shall be Type "UF", 600 volt, solid copper, single conductor wire with PVC insulation and bear UL approval for direct underground burial feeder cable.
2. Insulation shall be 4/64-inch (1.6mm) thick minimum covering of ICC-100 compound for positive waterproofing protection. All control or "hot" wires shall be of one color (black) and all common or "ground" wires shall be white. When more than one valve is operated by a single controller station, provide separate control wire from the controller to each valve, and one valve per box. Each valve should have no less than twenty-four inches (24") (600mm) of control cable inside valve box. Each wire shall be labeled at the valve box and at the controller to what zone each wire controls.

- A. Verification of wire types and installation procedures shall be checked to conform to local codes.

I. Fittings.

1. All plastic pipe fittings shall be permanently marked with the following information:
2. Manufacturer's name or trademark, size, schedule and type of pipe, working pressure at 73°F (23°C), and National Sanitation Foundation (N.S.F.) approval.

3. All plastic pipefittings to be installed shall be molded fittings manufactured of the same material as the pipe and shall be suitable for solvent weld or screwed connections.
4. Slip fitting socket taper shall be so sized that a dry unsoftened pipe end, conforming to these special provisions, can be inserted no more than halfway into the socket. Plastic saddle and flange fittings will not be permitted. Only schedule 80 fittings may be threaded.
5. When connection is plastic to metal, plastic male adapters shall be used. The male adapter shall be hand tightened, plus one turn with a strap wrench. Joint compound shall be Teflon Tape and Teflon paste. No oil based products permitted.
6. Fittings – Solvent Weld
 - i. All lateral line fittings and mainline fittings two inches (2”) (50mm) and smaller shall be schedule 40 solvent weld fittings.
 - ii. Fittings shall be manufactured by Lasco, Spears, or acceptable equal.

J. Pipe Sleeves

Pipe sleeves shall be Schedule 40 PVC pipe, or equal.

K. Concrete.

All concrete shall be 3,000 psi (20,700kPa) at 28 days, transit mixed. Provide certifications with each delivery.

L. Other Materials.

1. Materials to be furnished:

Supply as part of this contract the following tools:

Two keys for each automatic controller
Three RC $\frac{3}{4}$ quick coupler
33 DK valve key
SH-O Hose swivel

2. All other materials, not specifically described, but required for a complete and proper irrigation system installation, shall be new, first quality of their respective kinds, and subject to the approval of the City Representative.

204.07 Surface Conditions

A. Inspection

1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that trenching may be completed in accordance with the original design and the referenced standards.
3. In the event of discrepancy, immediately notify the City's Representative. Do not proceed with installation in areas of discrepancy until all discrepancies have been fully resolved.

204.08 Trenching

A. Perform all trenching required for the installation of items where the trenching is not specifically described in other sections of these Specifications.

B. Make all trenches in accordance with OSHA Requirements with sufficient width to provide free working space at both sides of the trench and around the installed item as required for gluing, joining, backfilling, and compacting while minimizing width of trenches.

C. Trench as required to provide the elevations shown on the Plans.

1. Trench to sufficient depth to give a minimum of fourteen inches (14") (350mm) of fill above the top of the pipe measured from the adjacent finished grade under driveways and sidewalks.
2. All mainline shall have a minimum cover of fourteen inches (14") (350mm) and a maximum cover of twenty inches (20") (500mm) above the pipe. All laterals shall be the same depth as the mainline. All lateral and main lines shall be installed in a straight line with no arching or bending of pipe. Change in direction of pipe shall occur only with the use of proper fittings only.

C. Where trench excavation is inadvertently carried below proper elevations, backfill with material approved by the City's Representative and then compact to provide a firm and unyielding subgrade to the approval of the City's Representative and at no additional cost to the City.

E. Trench Bracing

1. Properly support all trenches in strict accordance with all pertinent rules and regulations.

2. Brace, sheet, and support trench walls in such a manner that they will be safe and that the ground alongside the excavation will not slide or settle, and that all existing improvements of every kind will be fully protected from damage.
 3. In the event of damage to such improvements, immediately make all repairs and replacements necessary to the approval of the City's Representative and at no additional cost to the City.
 4. Arrange all bracing, sheeting and shoring so as to not place stress on any portion of the completed work until the general construction thereof has proceeded far enough to provide sufficient strength.
 5. Exercise care in the drawing and removal of sheeting, shoring, bracing, and timbering to prevent collapse or caving of the excavation faces being supported.
- F. Grading and Stockpiling Trenched Material
1. Control the stockpiling of trenched material in a manner to prevent water running into the excavations.
 2. Do not obstruct surface drainage but provide means whereby storm and waste waters are diverted into existing gutters, other surface drains, or temporary drains.
- G. All trench excavation shall be made by open cut. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading, and to prevent slides or cave-ins. The Contractor shall remove all material not required for backfill or not suitable for backfill, from the site. Banks of trenches shall be kept as nearly vertical as possible, and shall be properly sheeted and braced as may be necessary to prevent caving.
- H. Trench widths in paved streets or in areas where proximity to other structures require vertical cuts, shall not be wider than is required for proper handling, jointing and bedding of the pipe.
- I. The bottom of the trenches shall be accurately graded to line and grade, and provide uniform bearing and support for each section of the pipe on undisturbed soil, at every point along its entire length. Depressions for joints shall be dug after the trench bottom has been graded, and shall be only of such length, depth and width as required for properly making the particular type joint. Care shall be taken not to excavate below the depths indicated.

- J. Where rock occurs in trench excavation, the rock shall be removed to a depth of six inches (6") (150mm) below the established grade line, and to a width of twelve inches (12") (300mm) greater than the outside diameter of the pipe to be installed in the trench.
- K. Where excavation of trenches requires the removal of asphalt pavement, the pavement shall be cut in a straight line along the edge of the excavation by use of a spade-bitted air hammer, concrete saw, or similar approved equipment to obtain straight, square and clean break; and, after backfilling and subgrade preparations are completed, hot plant mix asphalt concrete shall be replaced and compacted in accordance with the appropriate standard specification. Replaced base course and asphalt shall match removed sections, with minimum of three inches (3") (75mm) asphalt concrete over five inches (5") (125mm) grading "W" base course.
- L. Excess material, including rock, broken concrete, bituminous materials, debris, or other materials not suitable for backfill, shall be removed from the site and disposed of by the Contractor.

204.09 Boring.

- A. Boring shall be used to route pipe, wiring, or both under concrete structures such as walks or curbs where trenching is impractical. Sleeves shall be installed in all bored holes.
- B. Boring shall be accomplished with a drill, auger, water jet, or any other instrument approved by the City's Representative capable of producing a precise hole. Boring shall not disturb overlaying structures or cause settlement and damage to those structures.

204.10 Sleeves.

- A. Sleeves shall be installed wherever routing of a pipe, wiring, or both crosses a paved area or passes through a bored hole.
- B. Sleeves laid in open trenches shall be uniformly and evenly supported by undisturbed soil on the trench bottom. Backfill shall conform to standards hereinafter specified.
- C. Sleeves installed in borings shall be forced through and shall have a snug fit throughout the length of the bored hole. Sleeves cracked or broken shall not be accepted.

204.11 Backfill

- A. The trenching shall not be backfilled until inspection, by the City's Representative, has been completed and the pipe installation, including the grade,

alignment, and jointing has been found to be in compliance with the requirements of the plans and specifications.

- B. Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than one inch (1") (25mm) shall be used in backfilling around and over the installed pipe.
- C. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The Contractor may at his option and own expense provide an acceptable imported material.
- D. This backfill material shall be carefully deposited around and over the pipe in layers not more than six inches (6") (150mm) thick, loose measurement, unless otherwise permitted by the City's Representative, wetted to optimum moisture content and uniformly compacted to at least 95 percent of the maximum density obtainable at optimum moisture content as determined by AASHTO T99 Method A or D (latest revision), until the pipe has a cover depth of at least 14 inches (350mm).
- E. The remaining depth of the trench shall be backfilled with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.
- F. Inclusion of a limited amount of stones and rocks larger than one inch (1") (25mm) will not be permitted.
- G. This material shall be carefully deposited in layers of a thickness suitable to the equipment selected by the Contractor for proper compaction and compacted to at least 95 percent of the maximum density as determined by AASHTO T99 Method A or D (latest revisions). The method of compaction selected by the Contractor shall not cause damage of any nature to the installed pipe.
- H. The use of water puddling of this portion of the trench backfilling may be used if the specified density can be obtained and the backfill material is suitable for this type of trench compaction.

204.12 Field Measurements

Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design.

204.13 Installation of Piping

- A. Perform all trenching and backfilling as specified by Section 204.08 and 204.11 of this Specification.

- B. Lay out the piping system in strict accordance with the plans.

Where piping is shown on the plans to be under paved areas but running parallel and adjacent to planted areas, the intention is to install the piping in the planted areas.

- C. All mainlines shall be installed with eighteen inches (18") (457mm) minimum cover, and a maximum of twenty-four inches (24") (610mm) cover, over the pipe. All laterals shall be installed a minimum of fourteen inches (14") (355mm), and a maximum of twenty inches (20") (508 mm) of cover over the pipe.

- D. All lines shall have a minimum clearance (horizontal and vertical) of four inches or within 4" (100mm) of adjacent pipe from each other, and six inches (6") (150mm) from lines of other trades, except through pipe sleeves. Parallel lines shall not be installed directly over one another.

1. Parallel lines shall not be installed directly over one another.

- E. Carefully inspect all pipe and fittings before installation, removing all dirt, scale, and burrs and reaming as required; install all pipe with all markings up for visual inspection and verification.

- F. Plastic Pipe

1. Plastic pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer.

2. All plastic joints shall be solvent-weld joints. Only the solvent cement recommended by the pipe manufacturer shall be used. All plastic pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer and it shall be the Contractor's responsibility to make arrangements with the pipe manufacturer for any field assistance that may be necessary. The Contractor shall assume full responsibility for the correct installation.

3. All plastic to metal joints shall be made with plastic adapters.

4. The solvent-weld joints shall be made dry.

5. The solvent-weld joints shall be allowed to set at least 24 hours before pressure is applied to the system on PVC pipe.

6. Swing joints shall be installed on the same side of the pipe as the head. Swing joints may not cross pipe laterally.

- G. Thrust Blocks

1. Provide concrete thrust for all pipe as required by the following schedule:

Sizes		Pipe Tees and Dead Ends				Elbows											
						22 ½ degrees				45 degrees				90 degrees			
		Length		Height		Length		Height		Length		Height		Length		Height	
In	Mm	In	Mm	In	mm	In	mm	In	mm	In	mm	In	mm	In	mm	In	mm
3-4	75-100	24	600	12	300	9	225	12	300	17	425	12	300	21	525	18	450
6	150	33	825	18	450	12	300	18	450	24	600	18	450	32	800	24	600
8	200	40	1000	24	600	16	400	24	600	30	750	24	600	45	1125	30	750
10	250	50	1250	30	750	20	500	30	750	40	1000	30	750	61	1525	36	900
12	300	61	1525	36	900	28	700	30	750	56	1400	30	750	87	2175	36	900

2. All thrust blocks shall bear directly on undisturbed earth. Pipe shall be centered in the middle of thrust block. Contractor shall install a plastic barrier between the thrust block and the pipe and/or wires, so as not to encase them in the concrete thrust block.

204.14 Installation of Equipment.

A. All fittings, valves, etc. shall be carefully placed in the trenches as shown on the plans.

1. All control wires shall be clearly labeled, by station, using weatherproof material, both at the controller and at the valve. The outside cover of all automatic valve boxes shall also have the station number clearly stamped on the cover.
2. All sprinklers, having adjustable nozzles, shall be adjusted for proper and adequate distribution of the water over the coverage pattern of the sprinkler.
3. All nozzles on stationary pop-up sprinklers or stationary spray heads shall be tightened after installation. All sprinklers having an adjusting screw, adjusting stem or adjusting friction collars shall be adjusted as required for the proper arc of coverage, radius, diameter and/or gallonage discharge.

B. Lawn Sprinkler Heads

1. Install lawn sprinkler heads where indicated on the plans and in strict accordance with the manufacturer's recommendations.
2. Along walks and driveways where finished grade is established, set all heads ¼” (5mm) below surface of pavement at time of installation and 1-1/2” (40mm) from pavement. Stake all temporary risers.
3. Set all heads to final grade where sod lawn will be installed.
4. Upon completion of maintenance period, reset all lawn sprinkler heads flush with grade and firmly anchor with soil.

204.15 Testing and Inspection.

A. Closing-in Uninspected Work

1. Do not allow or cause any of the work in this section to be covered up or enclosed until it has been inspected, tested, and approved by the City's Representative.
2. Where trenches are not closed at the end of the day Contractor shall accept all liability for any damage or injury that may result from open trenches. Provide barricades and warning tape as necessary around all open trenches.

B. Before backfilling the mainline, and with all control valves in place, completely flush and test the mainline and repair all leaks; flush out each section of lateral pipe before sprinkler heads are attached.

C. Testing

1. Make all necessary provisions for thoroughly bleeding the line of air and debris.
2. Before testing fill the line with water for a period of at least 24 hours.
3. After valves have been installed, test all installed irrigation lines for leaks at a pressure of 150 psi (1035 kPa) for a period of two hours, with all couplings exposed and with all pipe sections center loaded.
4. Furnish all necessary testing equipment and personnel.
5. Correct all leaks and retest until acceptance by the Engineer.

D. Final Inspection

1. Thoroughly clean, adjust, and balance all systems.
2. Demonstrate the entire system to the Engineer, proving that all remote control valves are properly balanced, that all heads are properly adjusted for radius and arc of coverage, and that the installed system is workable, clean, and efficient.

204.16 Record Drawings.

- A. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavement, etc.). Locations shown on as-built drawings shall be kept day to day as the project is being installed. All dimensions noted on drawings shall be neat and legible.

Show locations and depths of the following items:

- Point of connection
- Routing of sprinkler lines
- Ball valves
- Sprinkler control valves
- Quick coupling valves
- Routing of control and power wires
- Sprinkler heads
- Other related equipment

- B. Record drawings must be delivered to City's Representative upon completion.
- C. Copies of final plan of project to be maintained by the Parks Division shall be submitted to the Parks Division for reference.

204.17 Operations and Maintenance Manuals.

- A. Prepare and deliver to the City's Representative within ten calendar days prior to completion of construction, all required and necessary descriptive material in complete detail and sufficient quantity, properly prepared in four individually bound copies of the operations and maintenance manual. The manual shall describe the material installed and shall be in sufficient detail to permit operating personnel to understand, operate and maintain all equipment. Spare parts lists and related manufacturer information shall be included for each equipment item installed. Each complete, bound manual shall include the following information:
 - 1. Index sheet stating Contractor's address and telephone number, duration of guarantee period, list of equipment with names and addresses of local manufacturer representatives.
 - 2. Complete operating and maintenance instructions on all major equipment.
- B. In addition to the above maintenance manuals, provide the maintenance personnel with instructions for system operation and show written evidence to the City at the conclusion of the project that this service has been rendered.
- C. Final payment will not be made until record drawings and operation and maintenance manuals have been submitted and approved.

204.18 Warranty

- A. Warranty requirements will be in accordance with Division 100, Section 101.

B. The Contractor shall winterize the system and perform spring start-up of the system during the guarantee period. These functions shall be coordinated in advance with the City, and the City's personnel shall be encouraged to participate.

1. Upon re-energizing the system, the Contractor shall repair any leaks or breaks and shall check each head and valve, making any adjustment necessary.

204.19 Crossing and Repairing Existing Irrigation Systems

A. The Contractor shall coordinate all work with the City of Casper for locating the existing irrigation pipelines. The ends of the pipe shall be cleaned and plugged with a solvent weld cap. The pipeline shall be kept clean and free of debris.

B. After installation and backfilling the Contractor shall expose the irrigation crossings and repair the pipeline in accordance with this specification. The Contractor shall coordinate his activities with the City of Casper to ensure that the lines are adequately flushed and leak tested at static pressure following the repairs.

DIVISION 200

SECTION 204.5

ARBORICULTURAL SPECIFICATIONS AND STANDARDS

204.51 GENERAL.

This section contains information needed to install and maintain trees controlled by the City of Casper. All work on public trees shall comply with the city tree ordinances of the City of Casper. The arboricultural specifications and standards of practice shall be adhered to at all times, but may be amended at any time that experience, new research or laws indicate improved methods, or whenever circumstances make it advisable, with the approval of the City of Casper assigned certified arborist.

204.52 SUGGESTED SPECIES, CULTIVARS AND VARIETIES.

(A) The following trees are acceptable for planting on public property in the City of Casper. This list is not all inclusive, and acceptable alternatives may be approved by City of Casper certified arborists.

(1) LARGE TREES (50'+)

American Linden	Tilia Americana
Boulevard Linden.....	Tilia Americana 'Boulevard'
*Colorado Spruce.....	Picea Pungens
Bur Oak.....	Quercus Macrocarpa
Green Ash (<i>Several Cultivars</i>).....	Fraxinus Pennsylvanica
White Ash(<i>Several Cultivars</i>).....	Fraxinus Americana
Hackberry.....	Celtis Occidentalis
**Lanceleaf Cottonwood.....	Populus X Scuminata
**Narrowleaf Cottonwood.....	Populous Angustifolis
Ponderosa Pine.....	Pinus Ponderosa
Scotch Pine.....	Pinus Sylvestris

(2) Medium Trees (30' -50')

Black Ash.....	Fraxinus Nigra
Fall Gold Black Ash.....	Fraxinus Nigra 'Fall Gold'
Northern Gem Ash.....	Fraxinus 'Northern Gem'
Black Locust (<i>Several Cultivars</i>).....	Robinia Pseudoacacia
European Mountain Ash.....	Sorbus Aucuparia
Honeylocust	Gleditsia Triacanthos 'Inermis'
Imperial Honeylocust.....	Gleditsia Triacanthos 'Imperial'
Skyline Honeylocust	Gleditsia Triacanthos 'Skyline'
Little Leaf Linden	Tilia Cordata
Greenspire Little Leaf Linden.....	Tilia Cordata 'Greenspire'
Dropmore Linden.....	Tilia X Flavescens 'Dropmore'
Redmond Linden.....	Tilia X Euchlora 'Redmond'
Ash (<i>Several Cultivars</i>).....	Fraxinus Sp.
Ohio Buckeye.....	Aesculus Glabra
Oakleaf Mountain Ash.....	Sorbus X Hybridia
Emerald Lustre Norway Maple.....	Acer Platanoides 'Emerald Lustre'
Northfire Maple	Acer Rubrum 'Olson'

(3) Small Trees And Shrubs (Less Than 30')

Amur Maple (Tree Form)	Acer Ginnala
Amur Chokecherry.....	Prunus Maackii

Crabapples:

Pink Flowers:

Pink Spire Crabapple	Malus Sp. 'Pink Spire'
Radiant Crabapple.....	Malus Sp. 'Radiant'
Thunderchild Crabapple.....	Malus Sp. 'Thunderchild'

Red Flowers:

Centurion Crabapple	Malus Sp. 'Centurion'
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Hopa Crabapple	Malus Sp. ‘Hopa’
<i>White Flowers:</i>	
Dolgo Crabapple.....	Malus Sp. ‘Dolgo’
Flame Crabapple	Malus Sp. ‘Flame’
Snowdrift Crabapple	Malus Sp. ‘Snowdrift’
Spring Snow Crabapple	Malus Sp. ‘Spring Snow’
Gambel Oak.....	Quercus Gambelli
Globe Spruce.....	Picea Pungens ‘Globosa’
Lilac(<i>Several Cultivars</i>).....	Syringa Reticulata
**Laurel Leaf Willow.....	Salix Pentandra
Prairie Gem Flowering Pear.....	Pyrus Ussuriensis ‘Mordak’
Princess Kay Plum	Prunus Nigra ‘Princess Kay’
Showy Mountain Ash	Sorbus Decora
Shubert Chokecherry.....	Prunus Virginia ‘Shubert’
Hawthorn (<i>Several Cultivars</i>).....	Crataegus Sp.

**-No tree with a spread at maturity of more than ten feet (10’)(3m) at the base shall be planted in the boulevards.*

***All members of the genus Populous and Salix shall not be planted in the boulevards or within ten feet (10’) (3m) of all water and sewer lines.*

(B) Only desirable long-lived trees of good appearance, beauty, adaptability, and generally free from injurious pests or diseases shall be planted in public sites. The aforementioned species should serve as a guideline. However, other species that might prove hardy and of value in the landscape will be considered.

(C)The assigned arborist shall retain the right to refuse any species or cultivar that has a history of failure in the local landscape i.e. Soixland Cottonwood.

204.53 PLANTING.

(A) Size.

- (1) Unless otherwise specified by the assigned certified arborist, all medium or large deciduous tree species and their cultivars and varieties shall conform to the current American standard for nursery stock and be at least 1¼ to 1½ inches in diameter, six inches (6") (152 mm) above ground level, and at least eight to ten feet (8'-10') (2.4 – 3m) in height when planted. The tree shall have a well-branched crown typical of the species.
- (2) All small deciduous tree species and their cultivars or varieties shall be at least five (5') to six feet (6') (1.5-1.8 m) or more in height and have six (6) or more branches.

(B) Grade.

- (1) Unless otherwise allowed for specific reasons, all trees shall have comparatively straight trunks, well-developed single leaders and tops, and roots characteristic of the species, cultivar or variety showing evidence of proper nursery pruning. All trees must be free from insects, disease, mechanical injuries, and other objectionable features at the time of planting.

(C) Location and Spacing.

- (1) Spacing of trees should be determined by the assigned certified arborist according to local conditions, species, cultivars or varieties used, and their mature height, spread, and form. Generally, all large trees shall be planted forty (40') to sixty feet (60') (12-18m) on center, all medium sized trees shall be planted a minimum of thirty feet (30') on center, and all small trees shall be planted a minimum of twenty feet (20') (6m) on center.
- (2) Trees shall be planted at least ten feet (10') (3m) away from irrigation mainlines and all other known buried utilities.
- (3) No tree shall be planted closer than ten feet (10') (3m) to a utility pole or fire hydrant.

- (4) All planting within ten feet (10') (3m) curb and/or sidewalk must have the special permission of the assigned certified arborist representative who shall determine the tree's location so it will not be injured or destroyed when the street is curbed and paved.
- (5) Where overhead lines or building setbacks present a special problem, the selection of site and species shall be determined by the assigned certified arborist.

(D) Methods of Planting and Support.

- (1) All deciduous trees shall be planted, balled and burlapped, containerized and/or planted with a mechanical tree mover "spade" approved by the assigned certified arborist. If balled and burlapped, the top $\frac{3}{4}$ of the basket must be removed along with as much of the burlap as possible in order to prevent girdling roots.
- (2) All coniferous trees shall be planted, balled and burlapped, containerized and/or planted with a mechanical tree mover (spade) approved by the assigned arborist. Balled roots should be prevented from drying out at the surface of the ball and protected against injurious freezing. If balled and burlapped, the top $\frac{3}{4}$ of the basket must be removed along with as much of the burlap as possible in order to prevent girdling roots.
- (3) Pits dug for planting of bare-rooted plants shall be a minimum of twelve inches (12") (305mm) larger in diameter than the diameter of the root system, so as to be of sufficient size to accommodate the roots without crowding. For balled trees, the pits shall be a minimum of twenty-four inches (24") (610mm) larger in diameter than the diameter of the ball of soil to allow proper backfill.
- (4) Plants shall be planted so that the root crown is at the finished soil line or at the level at which it was grown in the nursery if that differs.
- (5) In poorly drained soil, artificial drainage shall be provided to properly drain the soil about the plant roots or tolerant species selected.

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- (6) The soil excavated from the planting pits shall be used for backfilling the plant except when otherwise specified by the assigned arborist. All stones larger than one inch (1") (25mm) in diameter shall be removed, and all lumps or clods shall be broken up before backfilling.
- (7) Pruning at the time of transplanting shall consist mainly of removing broken, dead, crossed and rubbing branches, and any remedial pruning necessary to improve the plants basic branch structure. The central leader shall not be removed, shortened, or otherwise destroyed.
- (8) Trees shall be suitably wrapped and guyed, or supported in an upright position according to accepted arboricultural practices. The guys or supports shall be fastened so that they will not girdle or cause serious injury to the tree or endanger public safety. Trees planted in late summer/autumn shall have the trunks wrapped to protect against frost damage. Trees planted in the spring shall have any such insulating wrappings excluded.

(E) Planting in the Sidewalk.

- (1) In those situations where trees are to be planted in the sidewalk, only those species and planting techniques specified by the assigned certified arborist will be allowed.

204.54 EARLY MAINTENANCE.

(A) General.

- (1) Newly planted trees require special attention to maintenance practices during one or two growing seasons following planting. All maintenance practices shall follow approved arboricultural standards.

(B) Watering.

- (1) Ample soil moisture shall be maintained following planting. A thorough watering each five (5) to ten (10) days, depending on soil type and drainage provisions, is usually adequate during the growing season. A soil auger or sampling tube is used to check the adequacy of moisture in the soil ball and/or backfill.

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(C) Fertilization.

- (1) Adequate quantities of the essential nutrient elements should be made available after new growth starts. Only organic fertilizers approved by the assigned arborist shall be used in the first two (2) years after planting.

(D) Insect and Disease Control.

- (1) Measures for the control of insects and diseases shall be taken as is shown necessary by frequent and thorough inspections. Where it is necessary to spray, insecticides or fungicides shall be used that are recommended for safe and effective control.

(E) Pruning.

- (1) Pruning practices to be followed the first few years following planting shall consist of removing dead, broken, or injured branches, the suppression of rank, uneven growth and usually the removal of water sprouts. Feather growth shall be removed as it reaches pencil size in diameter.
- (2) Pruning shall be practiced subsequent to transplanting and as necessary thereafter to assure sturdy crotch development.
- (3) Tree heads should be raised as growth characteristics and location dictate. Newly planted trees need not have lower branches removed until they are well established.

204.55 GENERAL MAINTENANCE.

(A) Pruning and Removal.

- (1) Pruning shall follow the current national arborist association arboricultural standards for pruning of shade trees. No “topping” of trees shall be permitted except with written permission of the city manager or duly appointed representative. Proper cabling and bracing shall be substituted for this practice whenever possible.
- (2) All established trees shall be pruned to sufficient height to allow free passage of pedestrians and vehicular traffic. A clear height of eight feet (8') (2.4m) over sidewalks and thirteen feet (13') (4m) over streets shall be maintained.

- (3) It shall be the policy of the assigned certified arborist to cooperate with the City Engineer, and vice versa, in the placement and height of lighting standards and the development of systems of tree pruning, to give effective street illumination.
- (4) All cuts shall be made with a saw or pruner and only at the branch collar. No stubs shall be left.
- (5) No spurs or climbing irons shall be used in the trees, except when trees are to be removed.
- (6) All dead, crossed, and rubbing branches shall be removed.
- (7) All tools being used on a tree suspected to be infected with a contagious disease shall be disinfected before being used on another tree.
- (8) Whenever streets are to be blocked off to public service, the traffic department shall be notified of the location and the length of time the street will be blocked. Notification shall be given to this department upon the removal of such barriers or if such barriers are to remain longer than originally expected.
- (9) To protect the public from danger, suitable street and sidewalk barriers, highway cones, or signs shall be used when pruning a tree. Flashing signals shall be placed on all barriers or obstructions remaining in the street after dark.
- (10) The stumps of all removed trees shall be cut to at least three inches (3") (76mm) below the ground surface. The contractor shall replace the topsoil and level the area.

(B) Spraying.

- (1) Suitable precautions shall be taken to protect and warn the public that spraying is being done.
- (2) Spraying shall be done only for the control of specific diseases or insects, with the proper materials in the necessary strength, and applied at the proper time to obtain the desired control. All spraying practices shall conform to federal and state regulations.

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- (3) Dormant oil sprays shall be applied only to certain species of trees as approved by the assigned arborist and only when the air temperature is 40°f or above and when it is not likely to drop below this temperature for a period of twenty-four (24) hours.

(C) Fertilization.

- (1) Fertilization of public trees shall follow the current National Arborist Association Standards for fertilizing shade and ornamental trees or other accepted arboricultural standards.
- (2) Formulations, rates, and methods of application of fertilizers shall be specified by the assigned arborist.

(D) Cavities.

- (1) Extensive cavity work should be performed on trees only if they are sufficiently high in value to justify the cost. All cavity work shall conform to accepted arboricultural standards approved by the assigned arborist.

(E) Cabling and Bracing.

- (1) As a general rule, cables should be placed approximately two-thirds (2/3) of the distance between the crotch and top branch ends. Rust resistant cables, thimbles, and lags should be used. The ends of the cable should be attached to hooks or eyes of lags or bolts, and thimbles must be used in the eye splice in each end of the cable. In no instances shall cables be wrapped around a branch.
- (2) All cabling and bracing practices shall follow current National Arborist Association Standards for guying of shade trees.

204.56 WARRANTY

- A. Warranty requirements will be in accordance with Division 100, Section 101.
- B. The contractor shall be responsible for all aspects of maintenance on all trees installed during the one-year warranty period.

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DIVISION 200

SECTION 205

EXCAVATION, TRENCHING, AND BACKFILL FOR UNDERGROUND FACILITIES

205.01 Description.

The materials and work covered under this section shall cover excavation, trenching, and backfill for underground utilities, crossing streets, roads, or alleys which surfaces have been improved with asphalt, concrete, or gravel.

205.02 Submittals.

Before placement of control density backfill, the contractor shall provide to the engineer and/or owner for review, information on the product data, mixture composition, and material testing characteristics.

205.03 Definitions.

- A. Control density backfill shall also be referred to as flow-fill, cement treated fill, non-shrink backfill or sand-cement slurry material. Controlled density backfill is a composite material that consists of water and a cement binding medium within which are embedded particles or fragments of aggregate.
- B. "Underground facility" means any item of personal property buried or placed below ground for use in connection with the storage or conveyance of electronic telephonic or telegraphic communications, cablevision, electric energy, oil, gas, hazardous liquids, or other substances and including, but not limited to, pipes, conduits, cables, lines, wires, manholes, attachments, and those parts of poles below ground. Underground facility excludes water, sanitary, or storm sewer conveyance or storage systems covered under other sections of this specification.

205.04 Materials.

- A. Cement. Cement shall conform to all requirements for cement set forth under Division 300, Section 301.
- B. Aggregate. Aggregate shall consist of fine aggregate and shall conform to all requirements for fine aggregate set forth under Division 300, Section 301.
- C. Admixtures. Pozzolan admixtures shall conform to all requirements for pozzolan admixtures set forth under Division 300, Section 301.

D. Pipe Zone Material. Pipe zone material shall conform to all requirements set forth under Division 600, Section 602 of the Standard Specifications.

205.05 Control Density Backfill Mixture Requirements.

A. Control density backfill shall meet the following requirements:

Mixture Requirements

<u>Property</u>	<u>Min.</u>	<u>Max.</u>
Cement factor (lbs. per cubic yard) (kg/cu.m)	50 (38)	60 (45)
Pozzolan admixture (lbs. per cubic yard) (kg/cu.m)	75 (57)	75 (57)
Water cement ratio (gal. per sack) (<i>lit</i> /sack)	6 (23)	
Slump (inches) (m)	7 (175mm)	

Minimum Compressive Strength

<u>Date of Break</u>	<u>Compressive Strength</u>
7 day	11 psi minimum (76 kPa)
28 day	30 psi minimum (210 kPa)
28 day	60 psi maximum(415 kPa)

B. The mix design for flow-fill can vary greatly provided that it meets a twenty eight day (28) compressive strength of between thirty and sixty pounds per square inch (30 – 60 psi) (210 – 415 kPa). An acceptable design can be found in section 02510 of the Wyoming public works standard specifications, “Portland cement treated mixtures”. The Engineer may modify this design to allow reject or recycled materials provided that the twenty eight day (28) compressive strength is confirmed by lab testing to be between thirty and 60 pounds per square inch (30 – 60 psi) (210 – 415 kPa). Non-specification material is not recommended for heavy loading or water and sewer crossings in which structural support depends on the flow-fills shear strength.

C. Air should be entrained at 1.5 – 2.5 % to improve workability.

205.06 Proportioning of Materials.

All materials shall be separately and accurately measured by weight, and each batch shall be uniform. Fine aggregates shall be weighed separately. A sack of cement shall weigh ninety-four pounds (94#) (43kg). When bulk cement is used, ninety-four pounds (94#) (43kg) shall be considered as one sack. The contractor shall furnish and use approved weighing devices, which, in operation, will give the exact quantity of materials required for the class of concrete. When the

cement is in contact with the aggregate, it shall not remain more than forty-five (45) minutes before being deposited into the mixer.

205.07 Measurement of Aggregate.

- A. Where sack cement is used, the quantities of aggregate for each batch shall be exactly sufficient for one or more sacks of cement. No batch requiring a fraction of a sack of cement will be permitted. All measurements shall be by weight, upon approved weighing scales and shall be such as will insure separate and uniform proportions. Scales shall be of either beam or springless dial types, and shall be suitable for supporting the hopper or hoppers. They shall be set accurately in substantial mountings which will insure a permanent spacing of the knife edges under all conditions of loading and use. They shall be so designed and maintained that they will at all times be accurate to within one-half (1/2) of one (1) percent throughout the entire weight range. Clearance shall be provided between the scale parts and the hopper or the bin structure to prevent displacement of the scale parts due to vibrations, accumulations, or any other cause. The value of the minimum gradations on any scale shall not be greater than five pounds (5#) (2kg). The weighing beam or dial shall be so placed that it will be in full view of the operator during the operation of the gate which delivers the material to the hopper. Scales shall be protected from air currents that may affect the accuracy of weighing.
- B. Separate hoppers shall be provided for weighing fine and coarse aggregate. They shall be of suitable size and tight enough to hold the aggregate without leakage, and shall be supported entirely upon the scales. Suitable provisions shall be made for removal of overload from the hopper by the operator while he operates the bin gates.
- C. The contractor shall provide a sufficient number of fifty pound (50#) (23kg) standard test weights for calibrating the weighing equipment.
- D. The volume of control density backfill mixed per batch shall not exceed the manufacturer's guaranteed capacity of the mixer.

205.08 Mixing Control Density Backfill.

- A. Consistency. The quantity of water to be used shall be determined by the engineer and shall not be varied without his consent. The contractor shall furnish and use with the mixer an approved adjustable, water measuring device which will prevent excess water flowing into the mixer, in order that the consistency may be under positive control and that all batches may be of the same consistency.
 - 1. In general, the minimum amount of water shall be used which will produce the required workability.
- B. Mixer. The mixing machine used shall be of an approved type known as a batch mixer, and of a design having a suitable device attached for automatically measuring the proper

amount of water accurate to one percent (1%) and for automatically timing each batch of control density backfill so that all materials will be mixed together for the minimum time required. Such device shall be easily regulated and controlled to meet the variable conditions encountered.

1. The normal mixing time for each batch shall be one (1) minute, and the measuring of this period shall begin after all the materials are in the drum. During this mixing period, the drum shall revolve at the speed for which the mixer is designed, but shall make not less than fourteen (14) nor more than twenty (20) revolutions per minute.
2. No materials for a batch of control density backfill shall be placed in the drum of the mixer until all of the previous batch has been discharged therefrom. The discharge of water into the drum shall commence with the flow of the aggregate, but shall not be started before the entrance into the drum of part of the aggregate. The discharge of all of the mixing water for any batch shall be completed within ten (10) seconds after all of the aggregate is in the drum. The inside of the drum shall be kept free from hardened control density backfill.
3. Control density backfill from a central mixing plant delivered at the work ready for use, will be permitted, provided the mixture is transported to the job site in an agitating truck having the control density backfill contained in a revolving drum and provided there is no segregation of the mixture at the point of placing. Control density backfill from a central batching plant and mixed in transit will be permitted; however, the mixing and transporting equipment will be subject to the special approval of the engineer. Any control density backfill shall comply with all of the requirements of these specifications. The control density backfill must be of workable consistency when placed. No mixer which has a capacity of less than a two-sack batch shall be used.
4. Hand mixing will not be permitted except with the permission of the engineer and then only in very small quantities or in case of an emergency.

205.09 Execution.

A. Excavation for Underground Facilities (General).

1. Excavate to the lines and grades shown, or as approved to accomplish construction. Allow for forms, working space, and materials types where required.
2. Do not excavate deeper than the elevations shown or approved. Excavations carried deeper than the elevations shown or approved shall be backfilled with approved compacted material. Excavation carried deeper than the elevations shown or approved shall be corrected by similarly cutting adjoining areas and creating a smooth transition to facilitate backfill and compaction. Backfill material type, placement, and compaction requirements shall be as determined by the engineer. The contractor shall bear all cost for correcting cuts below grade.

3. The bottom of all excavations shall be neat and clean, containing no abrupt changes in grade except as shown and shall be free from all slough. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material. The contractor shall correct any disturbance to underlying material by compacting soil material to at least 95% standard proctor, ASTM D698.
4. The engineer may direct excavations to be carried below the lines and grades shown on the drawings if, in the opinion of the engineer, such work is necessary to ensure adequate support of the proposed structure or pipe.

B. Dewatering

Dewatering, if required by site conditions, shall be provided by the contractor. The contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.

1. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12") (300mm) or more below the bottom of the excavation.
2. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.
3. The contractor shall be responsible for the conditions of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
4. All discharges from dewatering systems, including well points, dewatering wells, pumps in the bottoms of the trenches, etc. will require a permit from the Wyoming Department of Environmental Quality (WDEQ). Before starting any construction, the contractor shall submit an application to discharge to the WDEQ along with this proposed dewatering plan for review. The application shall be submitted on "National Pollutant Discharge Elimination System, Application to Discharge From a Construction Project, Short Form E". If the dewatering plan is revised during construction, a revised plan will be immediately sent to the WDEQ by Contractor. If there is any evidence of hydrocarbon or other contamination of the discharge water the discharge shall immediately cease and the DEQ shall be notified immediately. The Contractor will then comply with WDEQ conditions.
5. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineering office with the application for an

excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineering office.

C. Limits of Excavation

Conditions of the excavation permit may set limits of excavation designating the location of the completed utility and/or maximum dimensions of the excavation to prevent encroaching on adjacent improvements. Contractor shall confine excavation to those limits. Limits of excavation to safely accomplish the work shall be determined by the contractor. All excavations shall be free of overhangs and the sidewalls shall be kept free of loose material. As a minimum, slope all excavations to prevent these conditions and to comply with state OSHA regulations.

D. Disposal of Excess Material.

1. Except as otherwise permitted, dispose of excess excavated materials in a legal manner.
2. Dispose of broken concrete, rock and other debris resulting from utility construction activities in a legal manner, off-site.

205.10 Installation of Underground Facilities.

A. Trench Excavation.

1. Safety. The contractor shall not open up more trench in advance of the underground utility operations than what can be completely backfilled properly in one day's operation.
3. Asphalt and Concrete Removal. Where trench excavation or structure excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a spadebitted air hammer, concrete saw, or similar approved equipment to obtain a straight, square, clean break. Concrete shall be cut at the location of standard joint spacing. One half inch (1/2") (12.5mm) expansion joint material shall be installed between existing concrete and new concrete.
3. Limiting Pipe Zone Widths. Trenches shall be excavated to a width which will provide adequate working space and clearances for proper installation, jointing, and embedment of the underground utility. Excavated material shall be placed at a distance away from the sides of the trench equal to the depth of the trench. Install sheeting, shoring, bracing, and sloping as excavation proceeds.

B. Underground Utility Installation.

1. Reasonable care shall be exercised in handling and laying the underground utility materials and fittings. When strung along the trench, materials shall be placed where they will not be subject to injury from vehicles or equipment. The Contractor's facilities for lowering the utility into the trench shall be such that neither the underground utility materials nor trench will be damaged or disturbed.
2. Open excavation shall be satisfactorily protected at all times.

205.11. Trench Backfilling.

A. Trenches.

1. Encasement Material. Encasement material shall be placed to twelve inches (12") (300mm) above the utility, but in no case closer than twelve inches (12") to finish grade. Spread and surface grade encasement material to provide continuous and uniform support beneath the underground utility at all points. Encasement material shall be placed, prepared, and compacted simultaneously on both sides and lateral movement shall be prevented. Encasement material shall be compacted to 90% maximum density, as determined by ASTM D698 at a moisture content of $\pm 3\%$ of optimum for depths over forty-eight inches (48") (1.2m) below finish grade. Between forty-eight inches (48") (1.2m) below finish grade, compaction shall be a minimum of 95% of maximum density. Encasement material shall not exhibit pumping (horizontal or vertical displacement) after compaction.
 2. Trench Backfill Above the Encasement. Trench backfill above the encasement material and below the subbase course of the roadway may be select material moisture conditioned to +2% to -4% of optimum and compacted to 95% of maximum density as determined by ASTM D698. From the bottom of the subbase course of the street section to the surface, the material and material thickness shall comply with applicable portion of the City of Casper Standard Specification for public works construction. Trench backfill above the encasement may consist of control density backfill (CDB) material. CDB material shall be used when trenching beneath asphalt or concrete paved streets. CDB material shall be placed into the excavated trench by means of concrete chutes or tremie tubes. CDB material shall be placed to the bottom of the asphalt mat. CDB material shall be vibrated using a mechanical vibrator to consolidate the material.
 3. All trenches awaiting final paving shall be backfilled with properly compacted grading "W" base course. Paving shall be completed within two (2) weeks of the date the excavation was opened.
- B. Care of Utilities. In excavating and backfilling for pipelines or structures, extreme care shall be taken so as not to damage or injure any adjacent gas, telephone, sewer, water, power, television lines, or other utilities. In the event of damage to a utility, the utility

owner and the City Engineer, shall be notified immediately. See Division 100, Section 101.06 for more detail on utility locates.

205.12 Pavement Replacement

Asphalt or concrete paving, curb and gutter and sidewalk construction shall comply with applicable sections of the City of Casper standard specifications.

205.13 Cleanup.

- A. Construction cleanup and all backfill operations shall immediately follow installation of underground facilities. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc.
- B. During construction, all existing gutters, storm drains, runoff channels, etc., shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.
- C. See Division 100, Section 101 for additional cleanup requirements.

205.14 Protection.

It shall be the responsibility of the Contractor to protect from damage all freshly poured CDB material regardless of the location or type of structure for a minimum period of seven (7) days from date of installation.

205.15 Quality Control Testing.

- A. The owner or consultant shall employ a testing laboratory to perform test and submit test reports. Test reports will be reported in writing to City Engineering Office, consultant, owner, and Contractor as soon as possible upon completion of tests.
 - 1. Control Density Backfill. Concrete test cylinders will be made by a qualified technician from a certified material testing laboratory.
 - i. Tests may be required for each day's run or according to the following schedule:

<u>Total Cubic Yards of Control Density Backfill</u> (cu.m)	<u>Minimum Number of Tests (3 Cylinders Each)</u> (cu.m)
0 – 100 (0-75)	One for 7 days, two at 28 days
100 – 1000 (75-760)	One for each 50 cu. yds.(40)
1000 – 2000 (760-1525)	One for each 125 cu. yds. (95)
2000 and Over (1525)	One for each 175 cu. yds. (135) One for each 250 cu. yds. (190)

- i. Results of all tests shall be furnished to the engineer as soon as they are available.
 - ii. Slump. Slump tests shall be conducted in accordance with ASTM C172. A test shall be performed for each day's pour of control density backfill and for each set of compressive strength tests.
2. Compaction. Compaction testing shall be performed a minimum of once for each trench, for each two hundred feet (200') (61m) of trench and for each material used including asphaltic cement paving.

205.16 Standard Detail Sections.

205/1 Standard Trench Detail for Utility Cuts

DIVISION 200

SECTION 206

TEMPORARY TRAFFIC CONTROLS

206.01 Description

To establish uniform requirements for detours, signs and barricades, and traffic control plans associated with construction activities performed on or affecting City of Casper streets. All traffic control work shall comply with the "Standard Specifications for Road and Bridge Construction," Wyoming Highway Department, latest edition. The work in this article shall consist of furnishing, erecting, maintaining, relocating, and removing temporary traffic control devices at the locations specified on the drawings and as directed by the Engineer. All traffic control devices shall conform to the provision for construction signing as set forth in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) latest edition.

206.02 Traffic Control Products

A. Sign Panels

1. Sign panels will be constructed of ¾" plywood conforming to plywood sign panels and barricades of the standard specification for road and bridge construction; or 6061-T6 or 5052-H38 aluminum alloy sheeting conforming to ASTM B209.
2. Wood sign panels will be backed with metal backing angles; except that backing is not required for those sign panels 48" x 60" or smaller.
3. Aluminum sign panels will be 0.125" thick and backed with metal backing angles; except that those sign panels 48" x 60" or smaller may be:
 - i. 0.080" thick and backed with metal backing angles or 2 x 4 lumber; or,
 - ii. Unbacked, 0.125" thick.
4. Special signs which are unique to the project, i.e., signs not shown on the plans or included in part VI of the MUTCD, and signs shown on the plans which contain a message that is unique to the project, will be furnished by the contractor, as specified on the plans, and erected by the Contractor. Posts and hardware for fixed special sign installations, and all equipment for portable special sign installations will be furnished by the contractor. Post lengths will be specified by the Engineer. Upon removal, the special sign panels, posts,

hardware, and portable installation equipment will remain the property of the Contractor.

- i. Special signs will be erected on fixed mountings unless portable mountings are authorized by the Engineer.

B. Barrels will be plastic conforming to the MUTCD, with 6” wide reflective stripes.

C. Temporary markings

1. Temporary reflective pavement markings will be paint, preformed tape, or raised pavement markers, and will be suitable for use on either Portland cement concrete or asphalt pavements. Minimum acceptable standards are as follows:

- i. Paint used for temporary markings will be commercially manufactured highway striping paint. The paint will be applied without dilution.
- ii. All painted stripes will be 4” wide, and will be reflectorized by dropping or spraying glass beads onto the wet paint.
- iii. The reflective beads will conform to AASHTO Specification M247, type 1.

2. Temporary reflective pavement striping tape will be 4” wide, pressure-sensitive tape manufactured for use as pavement striping.

- i. Striping tape applied to finished pavement surfaces which will be returned to normal traffic use will be a removable type.
- ii. Striping tape applied to temporary pavement surfaces which will be obliterated may be a non-removable type.
- iii. Striping tape applied to the surface of intermediate lifts of asphalt pavement may be non-removable type, and may be let in place. If a removable type is used, it will be removed before placing the next lift.

3. Temporary retro-reflective raised pavement markers manufactured by Astro Optics of Schaumburg, Illinois, Model No. TPM, or Stimsonite Products of Niles, Illinois, Model No. 66, or an approved equal will be acceptable.

4. Temporary retro-reflective motorist guidance markers manufactured by Davidson Plastic Company of Kent, Washington, Model NO. TRPM, or TOM, or an approved equal will be acceptable. Temporary retro-reflective motorist guidance markers manufactured by Davidson Plastic Company of Kent,

Washington, Model No. TRPM, or TOM, or an approved equal will be acceptable.

206.03 Traffic Control Plans

- A. A complete traffic control plan shall be submitted to the Engineer and the Casper City Engineering office at least one week prior to the start of construction.
1. Traffic will be permitted to use the street at all times, unless a detour is specifically permitted on the drawings or by the Engineer. Access to all abutting residences and properties shall be maintained to the maximum extent possible.
 2. The Contractor shall construct and maintain temporary crossings, complete with flagmen, whenever necessary to expedite the work or to maintain traffic. The Contractor shall furnish not less than two flagmen at each location where loading or depositing of material requires the turning of the trucks on any highway or street and where the operation of construction equipment endangers traffic. Temporary crossings shall be of ample size to safely carry the load which comes upon them.
 - i. The Contractor shall maintain the streets in a passable condition. The work shall be conducted so as to create a minimum of inconvenience to traffic.
 - ii. Excavations which traverse a street shall be limited to one-half the width of the street at any one time, unless an emergency situation exists which requires that the entire width of the street be excavated. City Engineer's office approval is required prior to excavation traversing an entire street.
 3. The Contractor shall furnish sufficient signs and barricades to facilitate the directing of traffic. Unless directed otherwise by the Engineer, all signs and barricades shall conform to:
 - i. Within City of Casper: "Manual on Uniform Traffic Control Devices (MUTCD)," latest edition.
 - ii. On State highway right-of-way: "Traffic Control for Roadway Work Operations," current editions.
 4. The Contractor shall have a sufficient number of barricades and signs on hand prior to the start of the construction
 - i. Each detour sign shall be reflectorized and shall be illuminated with two battery-powered blinkers with six-inch (6") amber lenses.
 - ii. All barricades shall have blinker lights on each end.
 - iii. It shall be the Contractor's responsibility to make necessary checks and inspections of all lights and barricades every day, including Sundays and holidays.

5. Temporary suspension of work does not relieve the Contractor of the responsibility outlined in the above requirements.

206.04 Permits

- A. The Contractor shall obtain all necessary permits from the City Engineer's office for any closure of any street or portion thereof, as provided in the Casper Municipal Code. Along with the permit application, the Contractor shall provide a sketch showing traffic routing and traffic control devices to be used. The construction traffic control sketch shall be approved by the City Engineer's office before the permit is issued.

206.05 Street Closure

- A. The City Engineer may permit the closing of streets to all traffic for a period of time prescribed by the office if, in the City Engineer's Opinion, it is necessary.

DIVISION 200

SECTION 207

TRAFFIC SYSTEMS

207.01 Description

This specification includes the requirements for the installation, equipment, and materials associated with traffic system installation.

207.02 Related Documents

All equipment furnished under this contract shall comply with Section 624 of the Standard Specifications for Road and Bridge Construction (Wyoming Transportation Department), as specified herein.

207.03 Foundation Concrete

The concrete for the foundations for the traffic signal supports, luminaire supports, and a traffic signal controller base shall be four thousand pounds per square inch (4000 psi) (27,600 kPa) concrete complying with the requirements of Division 300, Section 301.

207.04 Materials and Installation

- A. One inch (1") (25mm) PVC Conduit, two inch (2") (50mm) PVC Conduit, four inch (4") (100mm) PVC Conduit.
 - 1. Plastic conduit shall be placed as shown on the drawings, and shall be Schedule 40 type.
 - 2. Conduit shall be jointed using a solvent welded slipfitter coupling to make a watertight joint.
 - 3. Where plastic conduit runs are placed parallel to other conduit runs or cross over one another, they shall be separated by a minimum of three inches (3") (75mm) of sand or soil cushion. All bending of conduit shall be carefully done to avoid damage. Free ends of conduit shall be capped to prevent the entry of moisture, dirt, or rocks.
 - 4. Plastic conduit shall terminate ten inches (10") (3m) from the top of pull box.

B. Pull Boxes

1. Pull boxes shall be of the type shown on the plans, and installed at locations shown. The contractor may, at his own expense, install such additional pull boxes that he may deem necessary to facilitate the work, with the approval of the Engineer.
2. The pull boxes shall be of the type as manufactured by "Armorcast."
 - a. Pull boxes shall be: Type "B" – thirty inches by seventeen inches by eighteen inches (30" x 17" x 18") (.75m x 425mm x 450mm) (LxWxD).
 - a. Pull boxes shall bear the wording "City of Casper" on the covers.
 - iii. Pull boxes shall be placed on a crushed stone base, as shown on the details.
 - a. This item includes excavation, placing of the pull box, electrical bond, backfill and repair of surface to the original condition.

C. Traffic Signal and Communication Cable

1. Cable shall be installed as shown on the plans and wiring schematics. For proper function of the signals, conductors shall be stranded copper conductors with spade type crimped terminals. Cable shall conform to International Municipal Signal Association (IMSA) Specification 20-1, 1984.
2. Cables shall be used as follows:
 - i. 3C No. 14 AWG
 - a. From controller cabinet junction box to pedestrian pushbutton on shaft. Direct runs to each support, no splices in pull boxes.
 - a. 5C No. 14 AWG
 - a. From terminal compartment or base of shaft to inboard signals on mast arms.
 - iii. 7C No. 14 AWG
 - a. From terminal compartment or base of shaft to signals at end of mast arm uprights.

- iv. 15C No. 14 AWG
 - a. Direct runs from traffic signal controller cabinet and pull box to terminal compartment or base of signal support shaft.
 - b. No splices in pull boxes.
 - v. 6 Pair, No. 16 AWG Signal Communication Cable. For signal interconnect system.
3. At the controller cabinet and pullbox and base of support poles, cables shall be tagged to show their routing. Individual wires shall be tagged with branded type wire markers that conform to the terminal they hook to.
 4. There shall be no splices of cables in pull boxes. Cable conductors shall terminate only at terminal block or base of signal supports.
 5. Cable within cabinets, pull boxes, etc., shall be neatly arranged. Powdered soapstone, talc, or other approved lubricants shall be used when inserting cable in conduit. Before proceeding to pull cable in the underground conduit runs, the contractor shall clean all dirt or accumulations of moisture from conduit runs.
 6. Cabinet pullbox and cabinet terminated by City staff.
- D. No. 6 AWG, No. 8 AWG, and No. 10 AWG
1. Conductors shall be used for electrical service to the controller, street lighting, and equipment bonding and ground.
 2. The conductor shall be stranded copper. The insulation for the conductor shall be THWN with a 600-volt rating.
 3. Conductors shall be joined in pole bases or pull boxes using watertight connectors. Connectors shall be readily accessible in pole bases through the hand hole.
 4. Fused connector shall be used only in pole bases to connect the service wires to the luminaire drop wire (3C No. 12 AWG). All drop wires from luminaries shall be 3C No. 12 AWG cable to the connectors in the pole bases. All fuses shall be the midget ferrule type rates at 10 amps.
- E. Controller, Controller Cabinet and Base
1. The traffic signal controller shall be an Econolite ASC/2-2100 with the following:

- i. Conflict Monitor – EDI MMU-16E
 - ii. Load Switches – EDI 510 Series (12 Load Switches)
 - iii. Flasher – EDI 810 Series
2. The controller cabinet shall be a Type "TS" 2 Econolite cabinet, unpainted aluminum shot-blasted finish. The cabinet shall be completely NEMA compatible with the following features:
 - i. All necessary panels and harnesses for local and telemetry and ASC/2M master telemetry.
 - ii. Wire for eight (8) channels of intersection detection (Veh phase 1-8), eight (8) channels of system detection, and four (4) channels of 3M-Opticom detectors.
 - iii. Surge Arresters EDCD-No SHP or approved equal.
 - iv. Heating element mounted on insulated spacers against cabinet wall (not directly to cabinet metal). Heating element terminals to be unexposed or electrically insulated to prevent accidental short-circuiting.
 - v. Terminals of mercury switch to be unexposed or electrically insulated to prevent accidental short-circuiting.
 - vi. Provide a separate 15-amp single pole branch circuit (12 AWG THWN) and circuit breaker for the cabinet-heating unit.
 - vii. On-Auto time switch.
3. The base and concrete apron shall be sized appropriately for the equipment. The anchor bolt size and location shall comply with manufacturer's recommendations.
4. Auxiliary Equipment
 - i. The following auxiliary equipment shall be placed in the cabinet, and wiring provided.
 - a. Model – US Robotics Sportstem 56 K
 - b. The opticom unit shall include the following:
 - phase selector model 752, and

- optical detector model 721, 711 or 722 and opticom detector cable model 138 (length as required).

F. Traffic Signals, 3 Color, 1 Way, 12-12-12 and 12-12-12 w/BP

1. Traffic signals to be furnished and installed by the contractor are shown on the plan. Typical signal mounting is shown on the detail sheet.
2. The traffic signal indications shall meet or exceed the general specifications and definitions for adjustable signal heads as specified in the Institute of Transportation Engineers Technical Report No. 1, USAS D-10.1-1966, UDC 656.057, with latest revisions, or as specified or altered herein.
3. All mast arm mounted signals shall have minimum road clearance of nineteen feet (19') (6m) to the bottom of the signal backplate.
4. The signal indication housing shall be made from die cast aluminum which is free of flaws, cracks, blow holes or other imperfections. Signal indication housings shall be constructed so that they can be individually attached to each other, are one piece, interchangeable, adjustable, and have holes top and bottom to receive a one and a half inch (1½") (37.5mm) fitting. Color: Federal Highway Yellow.
5. The optical unit shall consist of an LED lens of the appropriate size. The lens shall be of the color as shown on the plans. Each lens shall be a true to color.

The twelve-inch (12") (300mm) diameter signals have LED traffic signal 120-volt bulbs.

6. Each signal indication shall have a tunnel (open bottom) visor made from sheet aluminum no less than 0.050 inch (0.050") (1mm) thick. The length of tunnel visors shall be twelve inch (12") (300mm) for twelve inch (12") (300mm) diameter indications.
7. Backplates shall be supplied that fit the signal heads and form a five-inch (5") (125mm) border around them. The backplates shall be louvered, made from aluminum and painted with a flat black synthetic backing enamel. Holes shall be drilled in the backplates so that they can be attached to the signal heads supplied.
8. All mast arm signals shall be supported with Astro-Brac as manufactured by Pelco Products Inc.
9. All brackets used for assembling and mounting signal indications are to be entirely weather-tight. All mounting brackets shall be made from no less than

one and a half inches (1½”) (37.5mm) I.P.S. pipe so that the traffic signal control wires can be threaded through them.

10. All mounting brackets shall be fabricated so that when placed in use they supply plumb or level support and are securely attached to the supporting structure.
11. A terminal compartment (12 terminals) shall be furnished with each mounting bracket for shaft mounted signals.

G. Traffic Signal/Luminaire Support, Signal Mast Arms, Luminaire Arms

1. The complete mast arm signal and luminaire support assembly shall consist of a tapered round shaft, a “sweep type” tapered round mast arm, anchor bolts, and necessary nuts and associated appurtenances to provide a complete installation.
2. The design shall be as to latest edition of Wyoming Transportation Department Standard Specifications for Road and Bridge Construction. Shop drawings shall comply with Section 501.03 of those specifications, and shall be approved by the City of Casper prior to manufacturing the signal supports. The shop drawings shall show assumed signal head and sign placement, with loading, in addition to the requirements of Section 501.03.
3. Supports shall be designed for a section head at end of all mast arms, with two inboard signals. Sign area design shall be for a minimum of seven and a half square foot (7.5 ft²) (7m²) of sign near the end of support, and ten square foot (10 ft²) (9m²) street sign at the connection of the shaft and mast arm.
4. Wire hand holes, four inches by six inches (4” x 6”) (100mm x 150mm) (7.5 ft²) (7m²) shall be located on the shaft, one approximately eighteen inches (18”) (450mm) above the base and one opposite the mast arm connection for feeding wire into the mast arm.
5. Finish shall be galvanized. Any damage in shipment shall be repaired or replaced to the satisfaction of the Engineer.

H. Loop Detectors, Prefab

1. The loop detectors shall be placed at locations by Engineering or the Traffic Department. Size of the loops is shown on the Loop Schedule.
2. Wiring for the loops shall be encased in one-inch (1”) (25mm) rigid PVC conduit of the shape as shown on the plans.

3. Loop detector wire shall be No. 14 AWG, and comply with IMSA Specification 51-5-1984.
4. In place asphalt shall be removed to the base six inches (6") (150mm) outside the loop area. The area shall be resurfaced over the loops. Materials and workmanship shall be to City Standards.

I. Loop Amplifier, 4 Channel

1. The Vehicle Loop Detector Amplifier shall be 4 channels, contained in the same unit, of solid state construction, capable of detecting vehicles and motorcycles (digital) when passing over the loop areas placed in the pavement, as manufactured by the 3M Company, Model P824-OD, or approved equal.

J. Loop Lead-in Cable, 3M

1. The lead-in cable shall be Model CC-30003, as manufactured by the 3M Company. It shall consist of 4 No. 18 AWG stranded conductors enclosed in an aluminized shield and polyethylene jacket.
2. Connections of the cable to the loop detectors shall be made only in the pull box nearest the loop, using a waterproof connection.

K. Pedestrian Signal, ICC Unit

1. The pedestrian signal supplies shall be the unit as manufactured by Indicator Control Corp., Rancho Dominguez, California 90221, or approval equal.
2. The general construction of the Pedestrian Indications shall include a single piece cast aluminum housing, a sealed message module with a polycarbonate message lens, a single piece cast aluminum swing-down doorframe, and black-out egg crate type sun visor with clam shell mounting.
3. The approximate overall dimension of the signal shall be eighteen and a half inches (18½") (462mm) wide, eighteen and three-fourths inches (18¾") (460mm) high, and nine inches (9") (225mm) deep, including egg crate type visor and hinges.
4. The message module shall be sealed into an integral assembly with a one-piece sponge neoprene gasket fitted around the perimeter to provide positive protection of the enclosed lighting from handling, weather, and moisture. The message display shall be Don't Walk-Walk.

4. The message module shall be provided with electrical contacts which will plug directly into recessed contacts in the transformer enclosure when the module is in proper position, thus totally eliminating secondary high tension leads. Removal and insertion of the module shall not require the use of tools.
5. Each signal shall be provided with an egg crate type visor designed to eliminate sun phantom.
7. The case for pedestrian signals shall be dust proof, weatherproof, corrosion-resistant, and shall provide for easy access to and replacements of all components.
8. The case, doorframe, and egg crate visor (aluminum portion only) shall be thoroughly cleaned, and a chromate conversion coating applied inside and out per Military Specification MIL-C-5541. A synthetic enamel conforming to Military Specification IIE-520 shall then be electrostatically applied. The final finish shall be Flat Black for the door and face, and Federal Highway Yellow on other exterior areas.

L. Pedestrian Push Buttons

1. Pedestrian push buttons shall be furnished and installed by the contractor.
2. Pedestrian push buttons shall be installed on poles as indicated on the panels. Push buttons shall be located so that the arrow on the sign points in the direction of the pedestrian crossing, and so that the buttons are on the side of the pole most accessible to the pedestrian.
3. Signal standards shall be field drilled and tapped as required for wire entry and mounting of push buttons. The holes shall be treated with "Galvicon" (or an approved equal), per the manufacturer's directions, to protect against corrosion.
4. The pedestrian sign shall have the message as shown on the plans.

M. Opticom Cable

1. The Opticom control wire shall be M-138 Detector Cable as supplied by the 3M Company. The wire is 3-conductor No. 20 AWG, shielded cable with drain wire.

N. Aluminum Signs

1. Stop and yield signs shall be fabricated with 3m high intensity, all other sign faces and legends shall be fabricated 3M Reflective Engineering Grade, meeting FHWA specification FP74 level A.

2. All sign panels shall be .080 (2mm) thick anodized aluminum for signs less than six square feet (6 ft²) (5.5m²). Signs six square feet (6 ft²) (5.5m²) or larger shall have panels of .100 (2mm) thick anodized aluminum.
3. All standard signs shall be in accordance with the Manual Of Uniform Traffic Control Devices (MUTCD).
4. Sign attachments shall be Type "C" or "C", as shown on the plans, as to sign size. The signs are to be mounted on the mast arms and shafts as shown on the plans.
5. Ground mount signs shall be placed as directed by the Engineer. Mounting as to post size and attachment devices shall be to City Standards.

O. Luminaries, 250 W High Pressure Sodium Vapor (HPSV)

1. Luminaries shall be placed on each traffic signal/luminaire support. Luminaire assemblies shall be slipfitter type end mounting on a two-inch pipe tenon. Type M-N-III distribution, semi-cutoff shall be used on all luminaries. All luminaries shall be wired for 120 volts.
2. A photoelectric cell shall be part of each assembly, all units set to come on and off at approximately the same time.

207.05 Electric Service

- A. Service shall be from the location shown on the plans.
- B. Service equipment shall be for 120/240 volt, single phase service and include a meter base, surge protector and circuit breaker in NEMA 3R weathertight enclosure(s), of the type fabricated by Midwest Electrical Products.
- C. The main circuit breaker shall be 60 ampere, two pole. Branch circuit breakers shall be 40 ampere single pole for traffic signals and 30 ampere single pole for roadway lighting. The meter base shall be the manual bypass type as required by Pacific Power Company (verify prior to releasing order).

207.06 Pavement Markings

- A. Pavement markings shall be preformed for the crosswalk bars, arrows and messages, and pavement marking paint for lane lines, centerlines and other lines, as shown on the plans.
- B. The preformed pavement markings shall be Stamark 5730 with Stamark P46 adhesive, as manufactured by the 3M Company. The markings shall be placed as shown on the plans or as directed by the Engineer.

- C. Paint pavement markings shall meet the specifications of the Wyoming Department of Transportation for yellow and white paint, and shall be applied as to the same specification. The removal of the pavement markings in place shall be included under this item. Removal and placement of the pavement markings shall be as shown on the plans or as directed by the Engineer.

207.07 Sign Standards.

This guide will indicate the proper way to install City of Casper traffic signs and supports. Covered will be the installation process, materials used, mounting heights, locations and priorities.

A. Installation

The City of Casper currently uses the V-Loc telespar post system. The V-Loc base is driven into the ground with a special tool designed to fit the base. It is driven in flush with the surface and the square Telespar post is inserted into it using a special wedge to hold it in place. If the sign is to be installed in a concrete sidewalk, a piece of 6" PVC shall be placed in the ground prior to pouring. This will leave a free space to insert the V-Loc into the ground and leave room in case it must be removed later for any reason. This requires the fins to be cut off so it will fit. In the event of an installation in dirt, the fins shall be left intact. See the attached drawings.

B. Materials

The City of Casper uses the V-Loc sign support system manufactured by Tapco. It makes for easy installation and maintenance. The V-Loc holds the sign post in place using a metal wedge made by the same company. The sign support shall be a 12 gauge, 2" O.D. square perforated galvanized post. The perforations shall be 3/8" holes with 1" centers.

C. Mounting Heights and Positioning

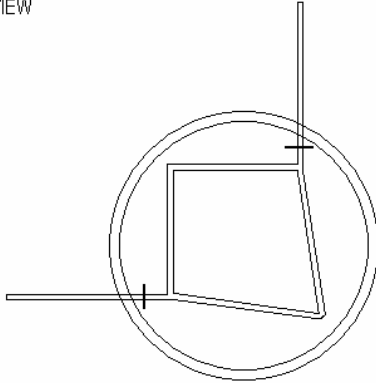
All traffic signs in the City of Casper shall conform to the Manual of Uniform Traffic Control Devices. (See figure 2A-1 in the MUTCD) A typical positioning for a neighborhood sign shall be two feet (2') (0.6 meters) from the edge of the curb to the nearest edge of the mounted sign. The sign shall be a minimum of seven feet (7') (2.1 meters) from the ground to the bottom of the sign.

D. Priorities

If an intersection has or will have stop or yield signs installed, the roadway shall not be opened to traffic until all signs have been properly installed. Motorist and pedestrian safety is the highest priority.

“LEFT BLANK ON PURPOSE”

TOP VIEW



V-LOC SIGN BASE FOR 2" SQUARE TUBING
6" PVC AND V-LOC MOUNTED FLUSH WITH SURFACE
FINS CUT OFF V-LOC WHERE INDICATED

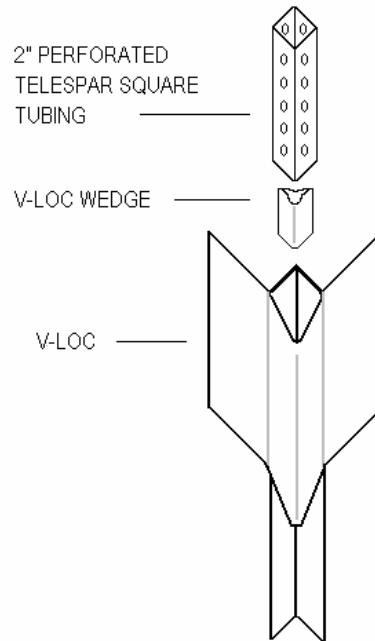
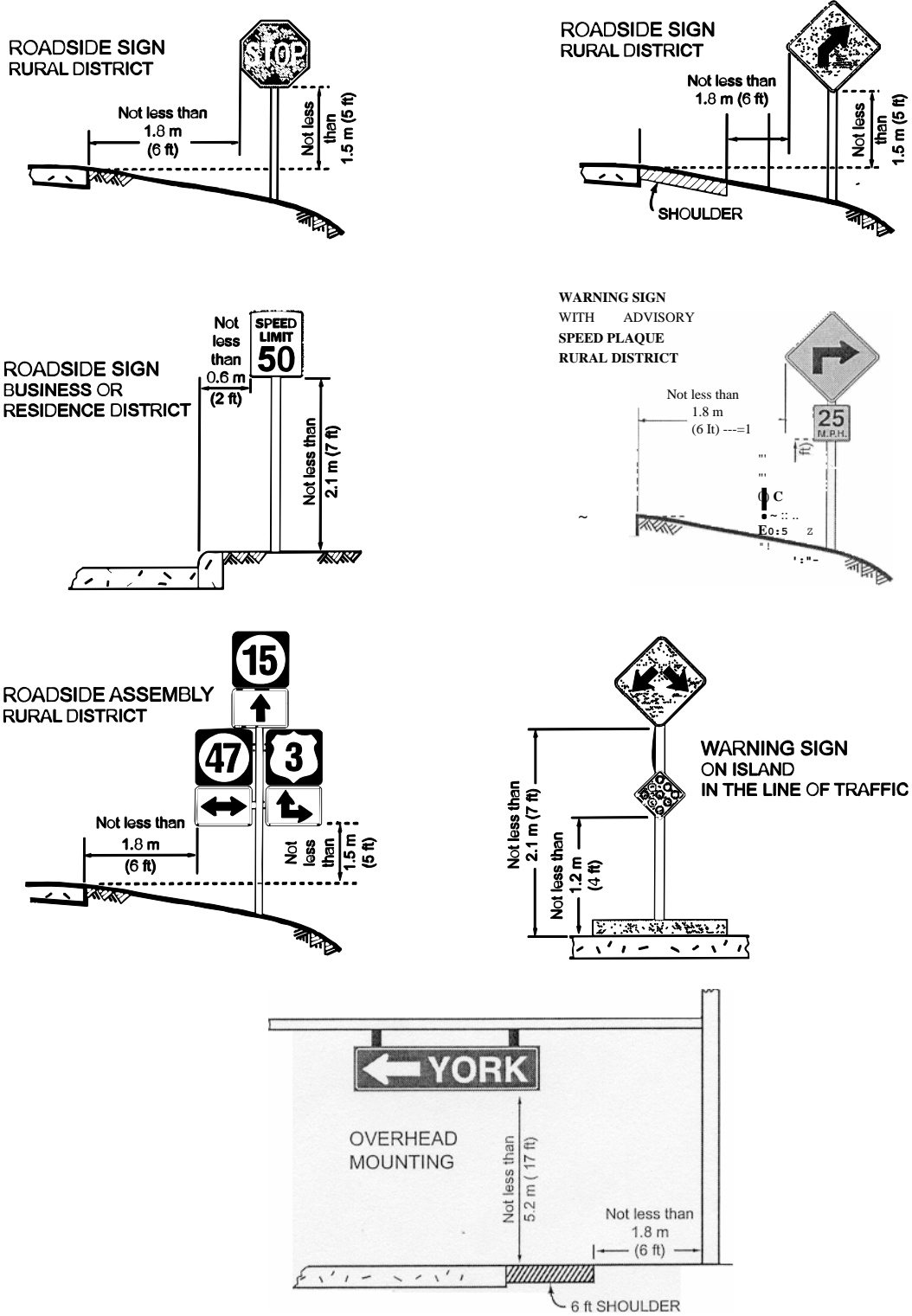


Figure 2A-1. Height and Lateral Location of Signs for Typical Installations



DIVISION 200

SECTION 208

ALLEYS

208.01 Description

This section includes requirements that are applicable to all types of work that impact the original condition of an alley.

208.02 Materials

Alley Rock: Shall consist of a hard durable, crushed, quarried natural stone. Alley rock shall be of such a gradation that one hundred percent (100%) shall pass the 1 ½" screen and no less than ninety percent (90%) by weight is retained on the ¾- inch screen.

Grading "W" Base: As defined in Section 402.02.

208.03 Construction Requirements

Once construction activities are finished the contractor shall return the disturbed alley in the following condition.

- 1.) If the construction was two feet (2') (600mm) or less in depth the contractor shall backfill with existing material and place two inches (2") (50mm) of alley rock over area of disturbance. Both the existing material layer and the alley rock layer shall be compacted with the use of mechanical compaction device. Finish alley rock grade shall match existing alley grade.
- 2.) If the construction was greater than two feet (2') (600mm) in depth the contractor shall restore the alley in the following manor. The contractor shall remove eight inches (8") (200mm) of existing material across the entire width and down the entire length of disturbed alley. The contractor may dispose of this existing material in the City of Casper landfill. The contractor will then arrange for a proof roll with the owner or the owners representative. Upon repairs of all soft spots the contractor shall place six inches (6") (150mm) of Grading "W" Base and compact the base to 95% of the maxim standard proctor. The contractor shall then place two inches (2") (50mm) of alley rock on top of the base layer. Both the base layer and the alley rock layer shall be compacted with the use of mechanical compaction device. Finish alley rock grade shall match existing alley grade. See attached standard drawing 208/1.

DIVISION 300

SECTION 301

PORTLAND CEMENT CONCRETE

301.01 Description.

This Article covers work necessary to furnish and place Portland cement. All terms and words used within this Article shall as be defined by ASTM C125.

301.02 Materials.

A. Cement.

1. Cement, Regular. Portland Cement shall conform to all requirements of the "Standard Specifications for Portland Cement," ASTM. Specification C150 for Type II modified, low C₃A (less than 5%).

B. Fine Aggregate.

1. Fine aggregate for concrete shall consist of sand and shall conform to the following ASTM requirements, ASTM C33, ASTM C136, and ASTM D75.
 - i. General Composition. Concrete sand shall be composed of clean (washed), hard, durable, uncoated grains, free from injurious amounts of clay, dust, soft flaky particles, loam, shale, alkali, organic matter, or other deleterious matter. Fine aggregate shall not contain appreciable materials which have unsatisfactory expansive properties when combined with Portland Cement and water. When required by the Engineer, expansion tests shall be made. Expansion shall not exceed 0.2 percent at age of one year as determined by ASTM Designation C-342.
 - ii. Sieve Analysis. Fine aggregate shall be graded within the following limits:

Sieve	% Passing by Weight	
	Min.	Max.
3/8" (9.5mm)	100	---
No. 4 (4.75mm)	95	100
No. 8 (2.36mm)	80	100
No. 16 (1.18mm)	50	85
No. 30 (600um)	25	60
No. 50 (330um)	10	30
No. 100 (150um)	2	10
No. 200 (75um)	0	4

Material shall be well graded and within the ranges stated above. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples submitted by the Contractor from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from a fineness modulus of the representative sample submitted by the Contractor, may be rejected. The fineness modulus is defined in ASTM Definition C-125.

Deleterious Substances. The fine aggregate shall not contain more than the following maximum amounts of deleterious substances:

	<u>Max. % of Weight</u>
Clay lumps	1.0
Coal, lignite, or shale	1.0

The sum of the above materials and other deleterious substances such as shale, alkali, mica, coated, grains, or soft and flaky particles shall not exceed 4% by weight.

- iv. Organic Impurities. Fine aggregate subjected to the colorimetric test as per ASTM C40 for organic impurities and producing a color darker than the standard shall be rejected unless it passes the mortar strength test as specified in Section 301.03(B) Organic Impurities ASTM C40.
- v. Soundness. Fine aggregate shall not have a loss greater than 15 percent weighted average loss at 5 cycles when tested in magnesium sulfate. Tests shall be made in accordance with ASTM C88.

C. Coarse Aggregate. Coarse aggregate for concrete shall consist of crushed stone or gravel and shall conform to the following requirements:

1. General Composition.

- i. Broken stone shall consist of clean (washed), hard, tough, durable fragments of rock (excluding schist, shale, or slate) of uniform quality throughout, shall be free from an excess of soft, thin, or elongated pieces, disintegrated stone, dirt, organic, or other injurious matter occurring either free or as a coating on the stone.
- ii. Gravel shall consist of clean, hard, durable uncoated pebbles and shall be free from soft, thin, or laminated pieces, disintegrated stone, dirt, organic, or other injurious matter occurring either free or as a coating on the gravel.
- iii. Coarse Aggregate shall not be obtained from sources of supply that contain appreciable percentages of material which is considered to have unsatisfactory expansive properties when it is combined with Portland Cement and water.

- iv. Percent Crushed Stone. Not less than fifty percent (50%) of the coarse aggregate by weight shall have at least one (1) fractured face.

Expansion shall be considered excessive when it exceeds 0.2 percent at age of one year. ASTM Designation C-342.

2. Sieve Analysis. The coarse aggregate shall be graded within one of the following limits. Aggregates for concrete shall be combined in proportions that will provide a mixture within the grading limits shown below, unless otherwise approved in writing by Owner. Not less than fifty percent (50%) of coarse aggregate, by weight, shall have at least one fractured face.

<u>Nominal Size of Material</u>	<u>% Passing by Weight</u>			
	<u>1-1/2"(37.5mm)Max.</u>		<u>3/4"(20mm) Max.</u>	
	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>
Passing 1 1/2" (37.5mm)	---	100	---	---
Passing 1" (25mm)	95	100	---	100
Passing 3/4" (20mm)	---	---	90	100
Passing 1/2" (12.5mm)	25	65	---	---
Passing 3/8" (9.5mm)	---	---	20	55
Passing No. 4 (4.75mm)	0	10	0	10
Passing No. 8 (2.36mm)	0	5	0	5

3. Deleterious Substances. The coarse aggregate shall not contain more than the following maximum amounts of deleterious substances:

	<u>Max. % of Weight</u>
Clay lumps	0.5
Material passing No. 200 sieve	2.0
Shale or coal	1.00
Other deleterious substances such as friable, thin, elongated, or laminated pieces	3.0

The sum of the above and other deleterious material shall not exceed 5% by weight.

4. Soundness. When subjected to 5 cycles of the soundness test, as set forth in ASTM C88, the loss in weight of coarse aggregate weighted in accordance with the grading of a sample complying with the grading requirements specified, shall not exceed 18 percent when magnesium sulfate is used, 12 percent for sodium sulfate.

5. Abrasion. The coarse aggregate shall not have an abrasive loss greater than 40% as determined by ASTM C131.

- D. Water for Concrete. The water shall be clean and free from objectionable amounts of oil, acid, alkali, organic matter, or other deleterious materials and shall not be used until the source of supply has been approved. If at any time the water from an approved source

becomes of unsatisfactory quality or insufficient quantity, the Contractor will be required to

provide satisfactory water from another source. Water of questionable quality shall be subject to the acceptance criteria of Table I, as specified in ASHTO T26.

- E. Air-Entraining Admixture. The Contractor shall use a regular Portland Cement with the addition of an air-entraining admixture meeting requirements of ASTM C260. Air-entraining admixtures to be used in air-entrained concrete shall be Darex AEA, Neutralized Vinsol Resin, and Protex, or any other air-entraining agent meeting the approval of the Engineer. Air-entraining admixtures shall contain no chlorides. The air-entraining characteristics of the admixture, in suitable proportions in combination with Portland Cement, fine aggregate and water, within the limits of the proportion specified, shall be such that the resulting concrete will have a satisfactory workability, and the total air content shall be as herein specified for the concrete as determined by ASTM Test C-138 or by the air meter.
- F. Chemical Admixtures. Chemical admixtures shall conform to ASTM C4 94, except TYPE C accelerating admixtures shall contain no chlorides, shall be non-toxic after thirty (30) days, and shall be compatible with air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.
- G. Pozzolan Admixture. Pozzolan admixture shall conform to the requirements of ASTM C311 and ASTM C618-85 (including Table IA) for either Class C or Class F. The amount of fly ash shall not exceed 15 percent of the total weight of flash ash plus cement.

301.03 Sampling and Testing Materials.

- A. Cement. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specifications, provided the cement is the product of a mill with a record for production of high quality cement. Certificates of compliance shall be furnished the Engineer by the Contractor, for each lot of cement furnished prior to use of cement in the work. This requirement is applicable to cement for job- mixed, ready-mixed, or transit-mixed concrete. Cement proposed for use where no certificate of compliance is furnished, or where, in the opinion of the Engineer, the cement furnished under certificate of compliance may have become damaged in transit or deteriorated because of age or improper storage, will be sampled at the mixing site and tested for conformance to the specifications.
 - 1. Cement will be approved for use if it satisfactorily passes the fineness, soundness, and time of set test requirements specified, provided the general run of materials has been satisfactorily meeting the 28-day strength requirements. Any approved cement failing to pass the 28-day strength requirements, if unused, shall be rejected. If, in the judgement of the Engineer, it is considered necessary, other lots of shipments from the same mill may be held for the results of tests before being used.
 - 2. If cement is supplied from a new source or from a source of unknown quality, it may be held for the results of strength test before being approved.
- B. Fine and Coarse Aggregate. At least two (2) weeks in advance of the beginning of concrete

work the Contractor shall submit to an approved materials testing laboratory approximately five hundred pound (500#) (225kg) samples of each concrete aggregate proposed for use. All tests which are necessary to determine the compliance of the concrete materials with these specifications shall be performed on these samples. These samples shall also be used by the laboratory as the basis for a concrete mix design. The results of all tests and the concrete mix design shall be submitted to and approved by the City Engineer prior to the start of any concrete work. Standards shall conform to the latest applicable codes. The sampling and testing shall conform to the following standard procedures:

FINE AGGREGATE

Sampling Aggregates	ASTM D75
Sieve Analysis	ASTM C117
Organic Impurities	ASTM C40
Fineness Modulus	ASTM C136
Soundness	ASTM C88
Clay Lumps	ASTM C142
*Potential Volume Change of Cement Aggregate Combinations	ASTM C342

* If required by Engineer.

COARSE AGGREGATE

Sampling Aggregates	ASTM D75
Sieve Analysis	ASTM C136
Percent Passing No. 200 Sieves	ASTM C117
Clay Lumps	ASTM C142
Soundness	ASTM C88
*Potential Volume Change of Cement Aggregate Combinations	ASTM C342

* If required by Engineer.

301.04 Storage of Materials.

- A. Cement. The Contractor shall provide adequate protection for the cement against dampness. No cement shall be used that has become caked or lumpy. Accepted cement which has been held in storage more than 90 days after shipment from the mill shall be retested, and if failing to meet the requirements specified herein shall be rejected.
 - 1. Accepted cement which has been stored in approved sealed bins at the mill for not more than six (6) months may be used without further testing unless a retest is specifically requested by the Engineer.

- B. Aggregate. Aggregates shall be handled and stored in separate piles at the site in such manner as to avoid a separation of the coarse and fine particles and contamination by foreign materials. Sites for stockpiles shall be prepared and maintained in such a manner as to prevent the mixing of deleterious materials with the aggregate. The Contractor shall deposit material in stockpiles at the batching plant site until the moisture content becomes uniform. Stockpiles

shall be built in layers not to exceed three feet (3') (1m) in height, and each layer shall be completed before beginning the next one.

1. Coning or building up stockpiles by depositing the materials in one place will not be permitted. The storing of aggregates in stockpiles, or otherwise, upon the subgrade or shoulders will not be permitted.

301.05 Concrete Mixture Requirements.

A. The concrete shall meet the following requirements:

TABLE OF CONCRETE REQUIREMENTS

<u>Property</u>		<u>Min.</u>	<u>Max.</u>
Cement factor	sks. per cu. yd. (sks/m ³)	6 (7.9)	
Water-cement ratio	gal. per sk. (l/sk)	4.5 (17)	5.5 (20)
Entrained air	per cent	4.5	7.5
Slump	inches (mm)	2 (50)	4 (100)

Volume Ratio of Fine to Total Aggregates

	<u>Min.</u>	<u>Max.</u>
	<u>Ratio</u>	<u>Ratio</u>
1" (25mm) Aggregate	0.40	0.55
3/4" (20mm) Aggregate	0.35	0.50
1/2" (12.5mm) Aggregate	0.30	0.46

Minimum Compressive Strength

28 day	psi(kPa)	4000 (27,600)
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1. If it is found impossible to produce concrete having the required air content with the materials and mixing procedures that are being used, the Contractor shall make such changes in the materials or mixing procedures, or both, as may be necessary to insure full compliance with the requirements of air content in the concrete.
2. The total weight of aggregates per sack of cement and the relative proportions of coarse and fine aggregate shall be determined by yield tests made during the progress of the work. The Engineer may, at his discretion, adjust the laboratory mix design to obtain the proper yield, and consistency of concrete.
3. The Contractor shall receive written permission from the Engineer prior to adding Pozzolan admixture to Portland Cement Concrete.
4. Any combination of aggregates which requires the use of more than six and one-half

gallons (6.5g) (25l) of water per sack of cement to produce a workable mixture, with the

brand of cement used will be considered as being unsatisfactory, and all such combinations of aggregate will be rejected.

5. Coarse aggregate having moisture absorption of more than 1.0 percent (1%) (as computed from oven dry to saturated surface dry basis) shall be saturated with water before it is used. The wetting shall be performed sufficiently in advance to permit complete filling of the open pores of the particles of aggregate.
6. Concrete shall be uniformly plastic, cohesive, and workable. Workable concrete is defined as concrete which can be placed without honeycomb and without voids in the surface. Workability shall be obtained without producing a condition such that free water appears on the surface when finished. The consistency of the mixture shall be that required for the specified conditions and methods of placement; however, the previously determined maximum water cement ratio shall not be exceeded.
7. The properties of the concrete mixture will be determined by the Engineer to insure compliance with these specifications. Modifications will be made in the material proportions as are necessary to provide satisfactory concrete. The above properties will be determined by the following methods:

Slump	ASTM C143
Weight Per Cubic Foot, Yield	ASTM C138
Compressive Strength of Cylindrical Concrete Specimens	ASTM C39
Making and Curing Concrete Test Specimens in Field	ASTM C31
Air Content by Pressure Method	ASTM C231
Fly Ash in Portland Concrete Cement	ASTM C618

301.06 Proportioning of Materials.

All materials shall be separately and accurately measured by weight, and each batch shall be uniform. The coarse and fine aggregates shall be weighed separately. A sack of cement shall weigh ninety-four pounds (94#) (43kg). When bulk cement is used, ninety-four pounds (94#) (43kg) shall be considered as one sack. The Contractor shall furnish and use approved weighing devices, which, in operation, will give the exact quantity of materials required for the class of concrete. When the cement is in contact with the aggregate, it shall not remain more than forty-five (45) minutes before being deposited into the mixer.

301.07 Measurement of Aggregate.

- A. Where sack cement is used, the quantities of aggregate for each batch shall be exactly sufficient for one or more sacks of cement. No batch requiring a fraction of a sack of cement will be permitted. All measurements shall be by weight, upon approved weighing scales and shall be such as will insure separate and uniform proportions. Scales shall be of either beam or springless dial types, and shall be suitable for supporting the hopper or hoppers. They shall be set accurately in substantial mountings which will insure a permanent spacing of the knife edges under all conditions of loading and use. They shall be so designed and maintained that they will at all times be accurate to within one-half (1/2) of one (1) percent throughout the entire weight range. Clearance shall be provided between the scale parts and the hopper or the bin structure to prevent displacement of the scale parts due to vibrations, accumulations, or any other cause. The value of the minimum gradations on any scale shall not be greater than five pounds (5#) (2.3kg). The weighing beam or dial shall be so placed that it will be in full view of the operator during the operation of the gate which delivers the material to the hopper. Scales shall be protected from air currents that may affect the accuracy of weighing.
- B. Separate hoppers shall be provided for weighing fine and coarse aggregate. They shall be of suitable size and tight enough to hold the aggregate without leakage, and shall be supported entirely upon the scales. Suitable provisions shall be made for removal of overload from the hopper by the operator while he operates the bin gates.
- C. The Contractor shall provide a sufficient number of fifty-pound (50#) (23kg) standard test weights for calibrating the weighing equipment.
- D. The volume of concrete mixed per batch shall not exceed the manufacturer's guaranteed capacity of the mixer.
- E. When the aggregates are delivered to the mixer in trucks, each batch shall be in a separate compartment of the capacity required by the Engineer. Suitable covers shall be provided for the batch compartments of the trucks to protect the cement from the wind. All trucks, truck bodies, bulkheads, and compartments used in proportioning and transporting to the mixer of concrete materials shall be so designed and operated to insure the charging of the mixer, batch by batch, with the proper amounts of each material without overspillage, intermixing of batches or wastage. Any units which, in the opinion of the Engineer, do not operate satisfactorily, shall be removed from the work until properly rebuilt and corrected.

301.08 Mixing Concrete.

- A. Consistency. The quantity of water to be used shall be determined by the Engineer and shall not be varied without his consent. The Contractor shall furnish and use with the mixer an approved adjustable, water measuring device which will prevent excess water flowing into the mixer, in order that the consistency may be under positive control and that all batches may be of the same consistency.
 - 1. In general, the minimum amount of water shall be used which will produce the required workability. The mortar shall cling to the coarse aggregate and shall show no free water

when removed from the mixer.

- B. Mixer. The mixing machine used shall be of an approved type known as a batch mixer, and of a design having a suitable device attached for automatically measuring the proper amount of water accurate to one percent (1%) and for automatically timing each batch of concrete so that all materials will be mixed together for the minimum time required. Such device shall be easily regulated and controlled to meet the variable conditions encountered. If the time device becomes broken or fails to operate, the Contractor will be permitted to continue the balance of the day without the timing device while the same is being repaired, provided that each batch of concrete is mixed two (2) minutes.
1. The normal mixing time for each batch shall be one (1) minute, and the measuring of this period shall begin after all the materials are in the drum. During this mixing period, the drum shall revolve at the speed for which the mixer is designed, but shall make not less than fourteen (14) nor more than twenty (20) revolutions per minute.
 2. No materials for a batch of concrete shall be placed in the drum of the mixer until all of the previous batch has been discharged therefrom. The discharge of water into the drum shall commence with the flow of the aggregates, but shall not be started before the entrance into the drum of part of the aggregates. The discharge of all of the mixing water for any batch shall be completed within ten (10) seconds after all of the aggregates are in the drum. The inside of the drum shall be kept free from hardened concrete.
 3. The use of mixers having a chute delivery will not be permitted except by permission of the Engineer. In all such cases the arrangement of chutes, baffle plates, etc., shall be such as will insure the placing of fresh concrete without segregation.
 4. Ready-mixed concrete from a central mixing plant delivered at the work ready for use, will be permitted, provided the mixture is transported to the job site in an agitating truck having the concrete contained in a revolving drum and provided there is no segregation of the mixture at the point of placing. Ready-mixed concrete from a central batching plant and mixed in transit will be permitted; however, the mixing and transporting equipment will be subject to the special approval of the Engineer. Any ready-mixed concrete shall comply with all of the requirements of these specifications. The concrete must be of workable consistency when placed. No mixer which has a capacity of less than a two-sack batch shall be used.
 - i. Hand mixing will not be permitted except with the permission of the Engineer and then only in very small quantities or in case of an emergency.
 5. In using air-entraining admixtures, the mixer shall be equipped with a suitable automatic dispensing device which will proportion the air entraining admixture accurately to each batch of concrete. The device shall be calibrated and adjusted to deliver to each batch of concrete the quantity of admixture required to produce the specified air content in the concrete.

6. The manufacturer of the concrete shall furnish to the purchaser with each batch of concrete before unloading at the site, a delivery ticket specifying information as outlined in Section 16.1 ASTM C94. The purchaser shall provide the Engineer with one (1) copy of each delivery ticket.

301.09 Protection.

It shall be the responsibility of the Contractor to protect from damage all freshly poured concrete regardless of the location or type of structure for a minimum period of seven (7) days or for such longer period as the Engineer may direct. Any concrete which is damaged shall be repaired to the satisfaction of the Engineer prior to acceptance of the completed work.

301.10 Quality Control Testing.

- A. The Owner or Consultant will employ a testing laboratory to perform test and submit test reports. Test reports will be reported in writing to Consultant, Owner, and Contractor as soon as possible upon completion of tests.

1. Compressive Strength Tests. Concrete test cylinders will be made by a qualified technician from a certified material testing laboratory.
2. The cylinders shall be made and tested in accordance with ASTM C39.
2. Tests may be required for each day's run or according to the following schedule:

<u>Total Cubic Yards of Concrete Placed (m³)</u>	<u>Minimum Number of Tests* (3 cylinders each)</u>
0 – 100(0-75)	One for 7 days, two at 28 days
100 – 1000 (75 -750)	One for each 50 cu. Yds. (38m ³)
1000 – 2000 (750 – 1500)	One for each 125 cu. Yds. (100m ³)
2000 and Over (1500)	One for each 175 cu. Yds. (125 m ³)
	One for each 250 cu. Yds. (200 m ³)

*One test per pour minimum.

- iii. Results of all tests shall be furnished to the Engineer as soon as they are available.
2. Slump. Slump test shall be conducted in accordance with ASTM C172. A test shall be performed for each day's pour of each type of concrete and for each set of compressive strength test.
5. Air Content. Air content shall be tested in accordance with ASTM C143 or ASTM C231. Air content test shall be performed for each set of compressive strength tests of each type of air-entrained concrete.

DIVISION 300

SECTION 302

CONCRETE CURB, CURB AND GUTTER, CURBWALK VALLEY GUTTERS, SIDEWALK, AND DRIVEWAYS

302.01 Description.

The work covered by this section consists of furnishing all equipment, labor, and materials necessary for constructing concrete curb, curb and gutter, curbside, valley gutters, sidewalks, and driveways on natural or prepared subgrades and bases, completed in accordance with the following specifications and dimensions shown on the plans.

302.02 Materials.

- A. Portland Cement Concrete. Portland Cement Concrete shall conform to the requirements specified under Division 300, Section 301.
- B. Reinforcing Steel and Fibers.
 - 1. Reinforcing steel for concrete reinforcement shall meet the requirements of ASTM A615, Grade 60.
 - 2. Welded wire fabric for concrete reinforcement shall meet the requirement as ASTM A185. Mesh shall be welded plain cold-drawn steel wire fabric.
 - 3. Reinforcing Fibers. Concrete reinforcing fibers shall be polypropylene collated, fibrillated fibers designed and engineered specifically for use as secondary reinforcement for concrete, shall be three-quarter inch (3/4") (20mm) to one inch (1") (25mm) in length and be manufactured by Fibermesh Company, Forta Corporation, or approved equal.
- C. Preformed Expansion Joint Material. Preformed joint material shall comply with the requirement of ASTM D994, ASTM D1751, or ASTM D1752.
- D. Leveling Base Course. Base course materials, if specified, shall conform to the requirements of sand with less than 10% passing No. 200 sieve.
- E. Forms. Concrete forms shall be wood, steel, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Forms shall be coated with a non-staining agent that will not discolor or deface surface of concrete.

- F. Curing Compound. Curing compound shall be poly-alpha-methyl-styrene (PAMS) meeting AASHTO 148 Class B, or engineer approved equivalent.
- G. Foundation Material. Refer to Division 600, Section 602.
- H. Aggregates. Course and fine Aggregates shall meet the requirements of ASTM C33 and Article 2. Concrete mix under this Section shall meet one and one half inch (1½") (37.5 mm) sieve size, as specified in Division 300, Section 301.

302.03 Subgrade and Base.

A. Natural Subgrades.

1. The subgrade shall be cut to a depth below finish grade sufficient to accommodate the thickness of a leveling base course and concrete specified. The upper eight inches (8") (200mm) of the subgrade shall be compacted to a dry density of at least 95% of maximum dry density as determined by ASTM D698 at a moisture content of $\pm 2\%$ OF optimum. The finished surface of the subgrade shall be smooth, free from surface irregularities, and true to line and grade as established by grade hubs or pins.
2. Compaction tests shall be performed a minimum of every one hundred fifty feet (150') (45m) of curb walk or side walk, once for each valley gutter, and once for each driveway not part of a section of curb walk being tested.
3. Trenches crossing curbwalk, valley gutters, or other concrete paving within the City right-of- way shall be compacted the full depth of the trench in accordance with Division 601.06. This applies to all trenches installed for any purpose.

B. Prepared Subgrades with Select Backfill.

1. Where spongy, organic, or otherwise unsuitable material is encountered, which, in the opinion of the Engineer is unsuitable for subgrade, such unsuitable material shall be removed to a minimum of twelve inches (12") (300mm) below the four inch (4") (100mm) thick leveling base course, and replaced with foundation material. The Engineer may direct the Contractor to excavate deeper than the specified twelve inches (12") (300mm). All select backfill material shall be compacted to 95% of maximum dry density, as determined by ASTM D698 at a moisture content of $\pm 2\%$ of optimum. Any boulders encountered shall be removed. Tree roots shall be removed at least one foot (1') (300mm) laterally and twelve inches (12") (300mm) vertically below all prepared subgrades.

C. Proof Rolling

Subgrades shall be proof rolled after compaction testing requirements have been passed and prior to placement of the leveling base course. Proof rolling shall be performed in the presence of the Engineer and a representative of the City Engineer's office.

D. Leveling Base Course.

1. Just prior to placement of concrete, the four inch (4") (100mm) thick leveling base course shall be accurately graded to conform to the grade of the forms, and sprinkled if necessary until the moisture content is at or near optimum moisture content. Optimum moisture content shall be determined by the Engineer in accordance with ASTM D698. In no case shall concrete be placed on a saturated base or if free water is standing on the base.

302.04 Forms.

- A. All forms shall be of wood or metal, straight, free from warp, and of sufficient strength when staked to resist the pressure of the concrete without springing, and the upper edge shall form a true line. Outside forms for the curbside shall be of a depth equal to the full depth of the sidewalk, and the inside forms shall be of the depth of the gutter and shall be so designed as to permit secure fastening to the outside form. All forms shall be cleaned thoroughly and greased or oiled before concrete is placed against them. Forms that have become worn, bent, or broken shall not be used. Forms shall be securely set true to line and grade.
- B. On short radii curves, steel plates, which can be readily formed to the desired radii, shall be used. Face forms, if used, shall be preshaped to the proper radii. Care shall be exercised to insure the maintenance of the required cross-section around the entire radius.
- C. The Contractor shall provide an approved metal straight edge, ten feet (10') (3m) in length for use in checking the alignment of the forms prior to placing the concrete and also to check the concrete surface during the finishing operation. Forms and the final product shall not deviate more than one-quarter inch (1/4") (6.25mm) from a straight edge ten feet (10') (250mm) in length and shall be sloped to achieve complete drainage without "bird baths."
- D. Forms shall remain in place at least twelve (12) hours after concrete has been placed against them or for a longer period if so directed by the Engineer. Crowbars or other heavy tools shall not be used against green concrete in removing the forms. Forms shall be well cleaned before reoiling and reuse.
- E. Screed guide templates shall be pulled prior to the concrete taking initial set. In those cases where initial set takes place prior to pulling of the templates, the joint shall be sealed with an asphaltic sealing compound approved by the Engineer.

302.05. Protection.

Protect fresh concrete from deleterious effects of weather and from traffic until adequately cured. Concrete shall not be placed on frozen subgrade or when weather is stormy, dusty, or otherwise inclement to the point that it precludes good workmanship. Air temperature shall be a minimum of 40° F (4°C) and rising when the pour is started. Adequate measures shall be employed to protect the concrete from freezing for a period of at least seventy-two (72) hours after it is poured. Concrete may be placed when air temperature is below 40° F if conditions stated in the Section 513.4.2 of the Standard Specifications for Road and Bridge Construction, Wyoming Department of Transportation, 2003 Edition are followed.

302.06. Joint Construction.

- A. Expansion Joints. All expansion joints shall be constructed straight, plumb, and shall extend through the full width and depth of the section. Expansion joint material shall be flush with the finished surface to three-quarters inch (3/4") (20 mm) below the finished surface. Edges adjacent to expansion joint material shall be tooled. Expansion joints shall be constructed at the intersection with any existing curbwalk or curb and gutter, at the tangent point of curb radii, at alley returns, and at intermediate intervals of not more than sixty feet (60') (18m) or at such lesser spacing as may be determined by the Engineer.

- B. Contraction Joints. Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals of five feet (5') (1.5m). Joint depth shall average at least one-fourth (1/4) of the cross- section of the concrete.
 - 1. Contraction joints may be sawed, handformed, or made by one-eighth inch (1/8") (3mm) thick division plates in the formwork. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be handformed either by 1) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete; or, 2) inserting one-eighth inch (1/8") (3mm) thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete.
 - 2. After removal of templates and finishing, contraction joints shall be reopened with a mason's trowel to a depth of one-fourth (1/4) the thickness of the section, the line of cut coinciding with and extending into the joint formed by the template. The joints shall be finished with a jointer.

- C. Construction Joints. At end of day's run, or in case of an interruption which would result in cold joint, construction joints shall be made at right angles to the longitudinal axis of the curbwalk and shall be located at the regular five foot (5') (1.5m) spacing designated for contraction joints unless otherwise specifically permitted by the Engineer. In no case shall any length of curbwalk be less than five feet (5') (1.5m) between joints.
 - 1. Construction joints shall be formed by use of a bulkhead or divider which shall be removed before continuing with the next run. Edges of construction joints shall be edge

tooled to form a recess for sealing compound.

302.07. Concrete Placement.

- A. Concrete shall be placed either by an approved slipform/extrusion machine, by the formed method, or by a combination of these methods. Concrete shall not be placed until base courses and forms have been checked for depth and alignment. The method used shall adequately vibrate and compact the concrete to achieve a homogeneous dense concrete free from honeycomb and pockets of segregated aggregate.
- B. Machine Placement. The slipform/extrusion machine approved shall be so designed as to place, spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.
- C. Formed Method. Construct forms to the shape, lines, grades, and dimensions called for in the Drawings. Set wood or steel forms securely in place, true to line and grade. Forms shall be braced to prevent change of shape or movement in any direction resulting from the weight of the concrete during placement. Tops of forms shall not depart from grade line more than one-fourth inch (1/4") (6.25mm) when checked with a ten-foot (10') (3m) straightedge. Alignment of straight sections shall not vary more than one-fourth inch (1/4") (6.25mm) in ten feet (10') (3m).

302.08. Finishing.

- A. Finishing shall be done with a metal screed or mule designed to give proper shape to the section as detailed. Particular care shall be used to finish the gutter flow line to a true, uniform grade that will drain completely without "bird baths". The back of the curbwalk and toe of the gutter shall be edge tooled. Traffic surfaces shall be broom finished at 90° to the direction of traffic. All honeycombed areas or small defects shall be patched with 1:2 mix mortar.
- B. After stripping forms, exposed concrete surfaces shall be finished smooth and even by means of a moist wood float or a moist brick.
- C. Sides of concrete exposed by the removal of forms shall be protected immediately to provide continuance of curing and preventing injury to the edge and the underlying subgrade. After the forms have been removed, suitable fill material shall be placed along the edge of the walk and tamped by either hand or mechanical tampers to a density at least equal to that of the adjacent ground. The finish grade and section shall be as indicated on the drawings and to the satisfaction of the Engineer.

302.09 Curing

Concrete shall be sprayed uniformly with curing compound immediately after finishing of the surface and before the set of the concrete has taken place. Curing compound shall be applied at the manufacturer's recommended rate. Curing compound shall also be applied immediately to the exposed concrete once forms have been removed. See section 302.02 for approved curing compounds.

302.10 Jointing New and Existing Curb Sections.

Where the new curbwalk sections will join existing curb or curbwalk with a different cross-section, a five foot (5') (1.5m) long minimum transition section shall be constructed.

302.11 Fiber Reinforced Concrete.

Where specified or approved by the Engineer, provide polypropylene fibers added to the concrete mix to control shrinkage cracks. Polypropylene fibers shall be added at the rate of three pounds (3#) (1.4 kg) of fiber per cubic yard of concrete. Fibers shall be added to the concrete in accordance with the manufacturer's recommendations.

302.12 Standard Detail Section

- 302/1 Standard Curbwalk Details for Existing Construction
- 302/2 Standard Curbwalk and Sidewalk Details
- 302/3 Standard Pathway Sections
- 302/4 Typical Concrete Curb and Gutter Section
- 302/5 Typical Concrete Curb and Gutter Section
- 302/6 Typical Curb Cut Section for Existing Construction
- 302/7 Driveways, Approaches & Median Cuts for ADA Accessibility
- 302/8 Standard Valley Gutter Sections
- 302/9 General Sidewalk Requirement for ADA Accessibility
- 302/10 Type I Perpendicular Curb Ramps for ADA Accessibility
- 302/11 Type II and Type III Curb Ramps

302.13 Cutting and Patching of Asphalt Paving.

When curb cuts, curb walk, or other concrete structures are installed adjacent to existing asphaltic concrete paving, the asphalt paving shall be saw cut parallel to and a minimum of eighteen inches (18") (450mm) away from the edge of the concrete. The excavation between the concrete and the asphalt paving shall be backfilled with a minimum of four inches (4") (100mm) of asphalt placed and compacted in two lifts over a minimum of six inches (6") (150mm) of compacted grading "W" base course. Base course and asphaltic concrete paving shall comply with City of Casper standard specification. Where the existing pavement and base course sections exceed the minimums specified above, the replacement thickness shall match the existing.

302.14 Colored Concrete

Colored concrete shall match the color of the concrete installed for curb ramps for ADA accessibility on other City projects. The color required is Solomon No. 489 Maroon dye added to City of Casper standard six (6) sack, 4,000 psi mix at a rate of 25 pounds per cubic yard.

DIVISION 300

SECTION 303

PORTLAND CEMENT CONCRETE PAVEMENT

303.01 Description.

This work shall consist of constructing a pavement composed of Portland cement concrete constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or designated by the Engineer.

303.02 Materials.

- A. Materials shall meet the requirements of Division 300, Section 301.
- B. Joint Fillers and Sealers. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise authorized by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape by stapling or other positive fastening satisfactory to the Engineer.
 1. Poured sealer for joints shall conform to the requirements of ASTM D3406-75T unless otherwise shown on the plans.
 2. Elastic Joint Sealer, where called for on the plans, shall be two component polyurethane or polysulfide-base sealant meeting the physical flow characteristics, and strength requirements of A.N.S.I. A116.1-1060.
 - i. Sealant for horizontal joints may be either Class A (self-leveling) or Class B (non-sag). Sealant for sloped or vertical joints shall be Class B.
 3. Preformed joint filler shall conform to the requirements of AASHTO M-213 unless otherwise shown on the plans, and shall be punched to admit the dowels where called for on the plans.
 4. Preformed Compression Joints shall be manufactured to the size and shape shown on the plans, from materials conforming to the requirements of ASTM D-2628.
 - i. The Contractor shall furnish a certification for each shipment of joints indicating that the material has been sampled, tested, and inspected in accordance with the provisions of ASTM D-2628. Each certification so furnished shall be signed by an authorized agent of the manufacturer or independent testing agency.

- ii. If recommended by the manufacturer, an approved lubricant-adhesive may be used to provide lubrication and bond for the joint. The lubricant shall be manufactured of material that is compatible with the sealer.

1. Curing Materials.

Curing compound shall be poly-alpha-methyl-styrene (PAMS) meeting AASHTO 148 Class B, or engineer approved equivalent.

303.03 Construction Requirements – Proportioning.

- A. The Engineer shall determine the proportions of the materials to be used that will produce a workable concrete having a maximum slump of three and one-half inches (3 ½”) (88mm), and the design flexural strength. The cement content shall not be less than 6.0 sacks per cubic yard. The water content including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall be not more than 5.3 gallons (20l) per sack of cement (water-cement ratio of 0.47).
- B. The percentage of air entrained in the mix shall be 6 ± 1 percent.
- C. When aggregates proposed for use on the project have been approved for use, the Engineer will designate the cement content per cubic yard; the maximum water-cement ratio; entrained air content; and the consistency of the mix. The cement content shall be that which an Independent Testing Laboratory has determined to be required for use with the particular combination of aggregates. The exact proportions will be based upon trial mixes with the materials to be used in the work and will be so adjusted to produce concrete of the required plasticity and workability. The proportions will be stated in terms of aggregates in a saturated, surface-dry condition, and the batch weights will have to be adjusted periodically to take into account the actual moisture content of the aggregates at time of use.
- D. The designated proportions shall govern during the progress of the work, except as provided below in Paragraphs 1 through 4, inclusive.
 1. If the cement content of the concrete varies by more than two percent (2%) from the designated value, the proportions will be adjusted by the Engineer so as to maintain a cement content which does not vary more than two percent (2%) from the designated value.

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2. If it is found impossible to obtain concrete of the desired plasticity and workability with the proportions originally designated by the Engineer, he will make such changes in aggregate weights as required, provided that in no case shall the cement content originally designated be changed except as provided below in Paragraphs 3 and 4.
3. If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable water-cement ratio specified, the cement content shall be increased as directed by the Engineer so that the maximum water-cement ratio will not be exceeded.
4. No change in the sources or character of the materials shall be made without due notice to the Engineer, and no new materials shall be used until approved by the Engineer and he has designated new proportions based upon independent laboratory tests and trial mixes.

303.04 Equipment.

- A. Equipment and tools necessary for handling materials and performing all parts of the work must meet the approval of the Engineer as to design, capacity, and mechanical condition, and the equipment must be at job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved.

1. Batching Plant and Equipment.

- i. General. The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size coarse aggregate. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The weighing hopper shall be properly sealed and vented to preclude dusting during operation.
- ii. Bins and Hoppers. Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant.
- iii. Scales. The scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within 0.5 percent throughout the range of use. When beam-type scales are used, provision, such as a "tell-tale" dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. A device on weighing beams shall indicate critical position clearly. Poises shall be designed to be secured in any position and to prevent inadvertent change. The weigh beam and "tell-tale" device shall be in full view of the operator while the hopper is charged, and he shall have convenient access to all controls.
 - a. Scales shall be tested as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have on hand not less than ten 50-pound (22.5 kg) weights for frequent testing of all scales.

- iv. Batching plants may be equipped to proportion aggregates and bulk cement by means of automatic weighing devices of an approved type.

B. Mixing.

1. General. Concrete may be mixed at the site of construction or at a central point, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.
2. Mixers at Site of Construction. Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge level when the drum has been charged and release it at the end of the mixing period.
 - i. The mixers shall be cleaned at suitable intervals. The pickup and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down one inch (1")(25mm) or more. The Contractor shall: 1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth; or 2) provide permanent marks on blade to show points of one inch (1")(25mm) wear from new condition. Drilled holes of one-fourth inch (1/4")(6.25mm) diameter near each end and at the midpoint of each blade are recommended.

C. Finishing Equipment.

1. Finishing Machine. The finishing machine shall be of an approved type.
2. Vibrators. Vibrators, for full width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Vibrators may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. Vibrators shall not come in contact with the joint, load transfer devices, subgrade, or side forms. The frequency of the surface vibrators shall not be less than 3,500 impulses per minute, and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators.
 - i. When spud-type internal vibrators, either hand-operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.

- D. Concrete Saw. When sawing joints is elected or specified, the Contractor shall provide soft-cut sawing equipment adequate in number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel at the required rate. The contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.
- E. Forms. Straight side forms shall be made of a metal having a thickness of not less than 7/32 inch (6mm) and shall be furnished in sections not less than ten feet (10') (3m) in length. Forms shall have a depth at least equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width equal to not less than the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of one hundred-foot (100') (33m) radius or less. Flexible or curved forms shall be of a design acceptable to the engineer. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than two-thirds (2/3) the height of the form.
1. Forms with battered top surfaces, and bent, twisted, or broken frames shall be removed from the work.
 2. Repaired forms shall not be used until inspected and approved. Built-up forms shall not be used except where the total area of pavement of any specified thickness on the project is less than two thousand square yards (2,000 sq.yds) (1700 sq.m). The top face of the form shall not vary from a true plane more than one-eighth inch (1/8") (3mm) in ten feet (10') (3m), and the upstanding leg shall not vary more than one-fourth inch (1/4") (6.25mm). The forms shall contain provisions for locking the ends of abutting form sections together tightly, and secure setting.

303.05 Preparation of Grade.

After the base has been graded and compacted, in accordance with the provisions for the material specified, the grade shall be trimmed approximately to correct elevation.

303.06 Setting Forms.

- A. Base Support. The foundations under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade with granular material and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting, as necessary.
- A. Form Setting. Forms shall be set sufficiently in advance of the point where concrete is being placed. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than three pins for each ten foot (10')

(3m) section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than one-fourth inch (1/4") (6.25mm) at any point. No excessive settlement or springing of forms under the finishing machine will be tolerated. Forms shall be cleaned and oiled prior to the placing of concrete.

- C. Grade and Alignment. The alignment and grade elevation of the forms shall be checked and corrections shall be made by the contractor immediately before the concrete is placed. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.
- D. Curbs and Gutters as Forms. In lieu of setting forms, the edge of a previously placed concrete gutter section may be used as a form.

303.07 Conditioning of Subgrade or Base Course.

- A. Prior to setting forms, the subgrade shall be prepared in accordance with Division 200, Section 201, Division 400, Sections 401 and 402.
- B. When side forms have been securely set to grade, the subgrade or base course shall be brought to proper cross section. Low areas may be filled and compacted to a condition similar to that of surrounding grade, or filled with concrete integral with the pavement. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.
- C. The subgrade or base course shall be uniformly moist when the concrete is placed. If it subsequently becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.

303.08 Handling, Measuring, and Batching Materials.

- A. The batch plant site, layout, equipment, and provisions for transporting material shall be such as to assure a continuous supply of material to the work. Aggregates from different sources and of different gradings shall not be stockpiled together.
- B. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least twelve (12) hours before being batched. Rail shipment requiring more than twelve (12) hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or nonuniform moisture content, storage, or stockpile periods in excess of twelve (12) hours may be required by the Engineer.

- C. The fine aggregate and each size of coarse aggregate shall be separately weighed into hoppers in the respective amounts set by the engineer in the job mix. Cement shall be measured by the sack or by weight. Separate scales and hoppers shall be used for weighing the cement, with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Ninety-four pounds (94#) (43kg) of bulk cement shall be considered one sack. Batches involving fractional sacks shall not be allowed, except when bulk cement is used.
- D. When required by the contract, or when permitted, batching plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved types.
- E. Methods and equipment for adding air-entraining agent or other admixtures into the batch, when required, shall be approved by the Engineer. All admixtures shall be measured into the mixer with an accuracy of ± 3 percent.

303.09 Mixing Concrete.

- A. The concrete may be mixed at the site of the work, in a central-mix plant, or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are in the drum. Ready-mix concrete shall be mixed and delivered in accordance with requirements of AASHTO M-157.
- B. When concrete is mixed at the site of the work or in a central mixing plant, the mixing time shall not be less than fifty (50) seconds nor more than ninety (90) seconds. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be completely removed before a succeeding batch is emptied therein.
- C. The mixer shall be operated at a drum speed as shown on the manufacturer's nameplate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to ten percent (10%) above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.
- D. The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform, and all water shall be in the drum by the end of the first fifteen (15) seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.
- E. Mixed concrete from the central-mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks having special bodies. The time elapsing from the time

water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed forty-five (45) minutes when the concrete is hauled in nonagitating trucks, nor ninety (90) minutes when hauled in truck mixers or truck agitators.

- F. Retempering concrete by adding water or by other means will not be permitted, except that when concrete is delivered in transit mixers or agitators, additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements, if permitted by the Engineer, providing the following conditions are met:
1. Maximum allowable water-cement ratio is not exceeded;
 2. Maximum allowable slump is not exceeded;
 3. Maximum allowable mixing and agitating time (or drum revolutions) are not exceeded; and,
 4. Concrete is remixed for at least half the minimum required mixing time or number of revolutions.
- G. Concrete that does not meet the above provisions shall be rejected. Admixtures for increasing the workability or for accelerating the set will be permitted only when specifically provided for in the contract.

303.10 Limitations of Mixing.

- A. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.
- B. Unless otherwise authorized, the temperature of the mixed concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40° F(4° C) and not resumed until an ascending air temperature in the shade away from artificial heat reaches 35° F(1.7° C).
- C. When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible concurrence of overheated areas which might injure the materials.
- D. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50° F(10° C) and not more than 90° F(32° C) at the time of placing it in the forms.
- E. If the air temperature is 35° F(1.7° C) or less at the time of placing concrete, the Engineer may require the water or the aggregates or both to be heated to not less than 70° F(21° C)

nor more than 150° F(66° C). No concrete shall be placed on frozen subgrade, nor shall frozen aggregates be used in the concrete.

303.11 Placing Concrete.

- A. The concrete shall be deposited on the grade in such manner as to require as little rehandling as possible. Unless truck mixers, truck agitators, or non- agitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such manner as to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly-mixed concrete with boots or shoes coated with earth or foreign substances.
- B. Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained 80% of design strength.
- C. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after three (3) days.
- D. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than fifteen (15) seconds in any one location.
- E. Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.
- F. Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

303.12 Testing.

- A. The Contractor shall furnish the concrete necessary for testing and shall cooperate fully with the Engineer in obtaining the material for testing purposes. Unless otherwise provided, the concrete shall be sampled, specimens made, and compliance determined in accordance with the following:

Slump	AASHTO T-119
Air content (gravel or stone)	AASHTO T-152 (Wyoming Modified)

(slag or highly porous aggr.)	ASTM C173
Cement content and unit weight	AASHTO T-121 (Wyoming Modified)
Strength (Compressive)	AASHTO T-22
(flexural, third point method)	AASHTO T-97
Making and curing test specimens in the field	AASHTO T-23

B. The beams will be cured in the field by the method specified for the pavement.

303.13. Strike-Off of Concrete and Placement of Reinforcement.

- A. Following the placing of the concrete, it shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans or established by the engineer. When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. Any portion of the bottom layer of concrete which has been placed more than thirty (30) minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed by mechanical or vibratory means in plastic concrete, after the concrete is spread.
- B. Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which would impair bond of the steel with the concrete.

303.14 Joints.

- A. Joints shall be constructed of the type and dimensions, and at the locations required by the Engineer.
1. Longitudinal Joint. Deformed steel tie bars of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints when shown on the plans. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two-piece connectors may be used.

- i. Longitudinal formed joints shall consist of groove, or cleft, extending downward from, and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the dimensions and line indicated on the plans and while the concrete is in a plastic state. The groove, or cleft, shall be sealed with either a premoulded strip or poured material as required.
 - ii. The longitudinal sawed joints shall be installed so that their ends are in contact with the transverse joints, if any.
 - iii. Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width, and line shown on the plans. Suitable guide line or devices shall be used to assure cutting the longitudinal joint as shown on the plans. The longitudinal joint shall be sawed before the end of the curing period or shortly thereafter and before any equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned using both water and compressed air. All pieces of concrete and aggregate and residue left from the sawing shall be removed from the joint immediately. Care shall be taken so that the depth of cut is uniform. Sealing shall then proceed as soon as the joint is dry.
 - iv. Longitudinal joints may be formed by placing a continuous strip of plastic or other material which will not react adversely with the chemical constituents of the concrete. The joint insert material shall be a strong, nonstretchable, three (3) mil thick, two-inch (2") (50mm) wide, polyester tape of such character, that when placed vertically in the concrete, it will not bond with the concrete and will form an effective weakened plane joint of two-inch (2") (50mm) minimum depth.
 - v. The joint material shall be inserted with a mechanical device that places the material in a continuous strip, except where intervening structures break the continuity of paving. Splices in the joint material will be permitted providing they are effective in maintaining the continuity of the joint material as placed. The joint material shall be placed in such manner that the top of the strip is not above nor more than one-fourth inch (1/4") (6.25mm) below the finished surface of the concrete. After placement, the vertical axis of the joint material shall be within ten degrees (10°) of a plane normal to the surface of the pavement. Final alignment of the strip shall be uniformly parallel with the center line of the pavement and shall not vary more than one inch (1") (25mm) from the edge of a twelve foot (12') (3.5m) straightedge. The installation device shall be designed to consolidate the concrete about the joint material. After installation of the joint material, the concrete shall be free of segregation, rock pockets, or voids, and the finished concrete surface on each side of the joint shall be in the same plane.
1. Transverse Expansion Joints. The expansion joint filler shall be continuous from form to form, shaped to the subgrade and to the keyway along the form. Preformed joint

filler shall be furnished in lengths equal to the pavement width or equal to the width of one (1) lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

- i. The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure performed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than one-fourth inch (1/4") (6.25mm) in the horizontal alignment from a straight line. If joint fillers are assembled in section, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.
3. Transverse Contraction Joint. Transverse contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement and, when shown on the plans, shall include load transfer assemblies.
- i. Transverse strip contraction joints shall be formed by installing a parting strip to be left in place.
 - ii. Formed grooves shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint.
 - iii. Sawed construction joints shall be created by sawing grooves in the surface of the pavement of the dimensions and at the spacing and lines shown on the plans with an approved concrete saw.
 - a. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually four (4) to twenty-four (24) hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing, and sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. All contraction joints in lanes and adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs. If extreme conditions exist which make it impracticable to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete as provided above.
 - b. When directed by the Engineer, random cracks shall be routed or sawed and filled with joint sealer. The sawed area shall be thoroughly cleaned using both water and compressed air. All pieces of concrete and aggregate and residue left from the sawing shall be removed from the joint immediately. Care shall be

taken so that the depth of cut is uniform. Sealing shall then proceed as soon as the joint is dry.

- iv. Transverse Formed Contraction Joints. These joints shall comply with the requirements for the longitudinal formed joint.
 - v. Transverse Construction Joints. Transverse construction joints shall be constructed when there is an interruption of more than thirty (30) minutes in the concrete operations. No transverse joint shall be constructed within five feet (5') (1.5m) of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least five feet (5') (1.5m) long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.
4. Load Transfer Devices. Dowels, when used, shall be held in position parallel to the surface and centerline of the slab by a metal device that is left in the pavement.
- i. The portion of each dowel on only one side of the joint shall be painted with one (1) coat of lead or tar paint, and shall be thoroughly coated with an approved lubricant, to prevent the concrete from binding to that portion of the dowel. An approved metal dowel cap or sleeve shall be furnished for each dowel bar used with the expansion joints. The caps or sleeves shall fit the dowel bar tightly.
 - ii. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

303.15 Final Strike-Off, Consolidation, and Finishing.

- A. Sequence. The sequence of operations shall be the strike-off and consolidation, floating, and removal of laitance, straight-edging, and final surface finish.
1. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.
- B. Finishing at Joints.
1. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated.
 2. After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be brought forward, operating in a manner to avoid damage to or misalignment of joints. If uninterrupted operation of the finishing machine, to, over,

and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be lifted and set directly on top of the joint and the forward motion of the finishing machine shall be resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, the screed shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without the screeds being lifted, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

- C. Machine Finishing. Unless otherwise permitted for small areas or for short periods of time due to equipment failure, all pavement concrete shall be vibrated. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and methods which will produce pavement conforming to the specifications.
- D. Hand Finishing. Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:
1. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.
 2. Narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical may be finished by hand methods.
 3. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.
 4. The screed for the surface shall be at least two feet (2') (50mm) longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and shall be constructed either of metal or other suitable material shod with metal.
 5. Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.
 6. In operation the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.
- E. Floating. After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated, by means of a longitudinal float, by the use of one of the following methods as specified or permitted:

1. Hand Method. The hand-operated longitudinal float shall be not less than twelve feet (12') (3.5m) in length and six inches (6") (150mm) in width, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion, while held in a floating position parallel to the road centerline, and shall be passed gradually from one side of the pavement to the other. Movement ahead along the centerline of the pavement shall be in successive advances of not more than one-half (1/2) the length of the float. Any excess water or soupy material shall be wasted over the side forms on each pass.
 2. Mechanical Method. The mechanical longitudinal float shall be of a design approved by the Engineer and shall be in good working condition. The tracks from which the float operates shall be securely adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by the engineer on each transverse trip. The float shall pass over each area of pavement at least two (2) times, but excessive operation over a given area will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass.
 3. Alternative Mechanical Method. As an alternative to Item 2 above, the Contractor may use a machine composed of a cutting and smoothing float, or floats, suspended from and guided by a rigid frame. This frame shall be carried by four or more visible wheels riding on, and constantly in contact with, the side forms.
 4. If necessary, following one of the preceding methods of floating, long-handled floats having blades not less than five feet (5') (1.5m) in length and six inches (6") (150mm) in width may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of, or supplementing, one of the preceding methods of floating. When strike-off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge ten feet (10') (3m) or more in length. Successive drags shall be lapped one-half of the length of the blade.
- F. Straightedge Testing and Surface Correction. After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a ten-foot straightedge. For this purpose the Contractor shall furnish and use an accurate ten-foot (10') (3m) straightedge swung from handles three feet (3') (1m) longer than one-half (1/2) the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the road centerline and the whole area gone over from one side of the slab to the other, as necessary. Advance along the road shall be in successive stages of not more than one-half (1/2) the length of the straightedge.

Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall be continued until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section.

G. Final Finish. The final finish will be specified on the plans as to the type of surface texture. The following types of surface textures may be specified:

1. Type I - Transverse Tining. The mainline finish shall be produced by mechanical equipment described as follows: The transverse grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb at the end of the pavement. Hand grooving methods will be permitted in a manner approved by the engineer in those areas where the mechanical equipment cannot be used.
 - i. This equipment shall have rectangular or circular shaped spring steel tines which are randomly spaced at one-half inch (1/2") (12.5mm) to one inch (1") (25mm) intervals from center to center. The grooves shall be made perpendicular to the center line of the pavement and the resulting transverse grooves shall be .090 (2mm) to .125 (3mm) inches wide and shall be one eighth inch (1/8") (3mm) to three-sixteenths inch (3/16") (4.5mm) deep.
 - ii. Acceleration lanes, deceleration lanes, and irregular sections may be finished by methods other than mechanical provided they produce a similar type of transverse groove.
2. Type II - Longitudinal Tining. The mainline finish shall be produced by mechanical equipment described as follows: The longitudinal grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb at the end of the pavement. Hand grooving methods will be permitted in a manner approved by the engineer in those areas where the mechanical equipment cannot be used.
 - i. This equipment shall have rectangular or circular shaped spring steel tines which are randomly spaced at one-half inch (1/2") (12.5mm) to one inch (1") (25mm) intervals from center to center. The grooves shall be made parallel to the center line of the pavement and the resulting longitudinal grooves shall be .090(2mm) to .125 (3mm) inches wide and shall be one-eighth (1/8") (3 mm) to three-sixteenths (3/16") (4.5mm) inches deep. The mechanical equipment shall be operated from a bridge when the pavement is sixteen feet (16') (5m) or more in width.

- ii. Acceleration lanes, deceleration lanes, and irregular sections may be finished by methods other than mechanical, provided they produce a similar type of longitudinal groove.
3. Type III - Nylon or Artificial Grass Drag. The pavement finish shall be produced by a nylon or artificial grass drag as approved by the Engineer. A uniform surface of gritty texture shall be produced by pulling the drag longitudinally. For a pavement width of sixteen feet (16') (5m) or more in width, the drag shall be mounted on a bridge which travels on the forms. The drag shall be at least three feet (3') (1m) wide and in full contact with the full width of the pavement. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new ones substituted.
4. Type IV - Nylon or Bristle Broom. The surface texture produced by a broom shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes lightly overlapping. The brooming operation shall be so executed that the corrugations produced in the surface shall be uniform in appearance and shall have a minimum depth of approximately one-sixteenth inch (1/16") (1.5 mm) and a maximum depth of approximately one-eighth inch (1/8") (3mm). Brooming shall be completed before the concrete is in such condition that the surface will be torn or unduly roughened by the operation. The finished surface shall be free from rough and porous areas, irregularities and depressions resulting from improper handling of the broom. Mechanical brooming, in lieu of the manual brooming, will be permitted if satisfactory results can be obtained.
5. Type V - Belt Finish (Paving with Rigid Forms). When straightedging is complete and the water sheen has practically disappeared and just before the concrete becomes nonplastic, the surface shall be belted with a two-ply canvas belt not less than eight inches (8") (200mm) wide and at least three feet (3') (1m) longer than the pavement width. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the road centerline and with a rapid advance parallel to the centerline.
6. Type VI - Burlap Drag. The drag shall be a seamless strip of damp burlap or cotton fabric which shall produce a uniform surface of a gritty nature after dragging it longitudinally along the full width of pavement. For pavement sixteen feet (16') (5m) or more in width, the drag shall be mounted on a bridge which travels on the forms. The dimensions of the drag shall be such that a strip of burlap or fabric, at least three feet (3') (1m) wide, is in contact with the full width of pavement surface while the drag is used. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags shall be substituted.

- i. When final longitudinal texturing has been completed by the burlap drag, the plastic pavement surface shall be textured by the designated type of texture and in a manner as approved by the Engineer. A belt finish need not be preceded by a burlap drag.
- H. Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required by the plans. A well defined and continuous radius shall be produced, and a smooth, dense mortar finish shall be obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.
1. At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. The rounding of the corner of the slab shall not be disturbed when the surface is broomed. All concrete on top of the joint filler shall be completely removed.
 2. All joints shall be tested with a straightedge before the concrete has set, and correction shall be made if one side of the joint is higher than the other or if an edge is higher or lower than the adjacent slabs.

303.16. Surface Test.

- A. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a ten-foot (10') (3m) straightedge or other specified devices. Areas showing high spots of more than one-fourth inch (1/4") (6.25mm) but not exceeding one-half inch (1/2") (12.5mm) in ten feet (10') (3m) shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of one-fourth inch (1/4") (6.25mm) when tested with a ten-foot (10') (3m) straightedge. Grinders shall be of the stacked head, vertical blade type that will not polish or smooth the surface but will provide a coefficient of friction approximately equal to that of the unground pavement. Grinding grooves shall be kept parallel with the direction of travel. Where the departure from correct cross section exceeds one-half inch (1/2") (12.5mm), the pavement shall be removed and replaced by and at the expense of the Contractor.
- B. Any area or section so removed shall be not less than five feet (5') (1.5m) in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than five feet (5') (1.5m) in length shall also be removed and replaced.

303.17 Curing.

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured

in accordance with one of the following methods. Failure to provide sufficient cover material of whatever kind the contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations.

The concrete shall not be left exposed for more than one-half (1/2) hour between stages of curing or during the curing period.

- A. Cotton or Burlap Mats. The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighed down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for seventy-two (72) hours after the concrete has been placed, unless otherwise specified.

- B. Waterproofed Paper. The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least eighteen inches (18") (450mm). The paper shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The paper shall be of such dimensions that each unit as laid will extend beyond the edges of the slab at twice the thickness of the pavement or shall be of pavement width and two foot (2') (600mm) strips of paper provided for the edges. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together, the joints being securely sealed in such a manner that they do not open up or separate during the curing period. Unless otherwise specified, the covering shall be maintained in place for seventy-two (72) hours after the concrete has been placed. The surface of the pavement shall be thoroughly wetted prior to the placing of the paper.

- C. White Pigmented Impervious Membrane. The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with burlap or cotton mats, the curing compound may be applied upon removal of the mats.
 1. The curing compound shall not be applied during rainfall.
 2. Curing compound shall be applied under pressure at the rate of approximately one (1) gallon (3.785l) to one hundred fifty square feet (150 sq.ft) (140 sq.m) by mechanical sprayers. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During the application the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and on concrete surfaces exposed by the

removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed.

3. The curing compound shall be of such character that the film will harden within thirty (30) minutes after application. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound.
 4. Upon removal of side forms, the sides of the slabs exposed shall be protected immediately to provide a curing treatment equal to that provided for the surface.
- C. White Polyethylene Sheeting. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least eighteen inches (18") (450mm). The sheeting shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for seventy-two (72) hours after the concrete has been placed.
- D. Curing in Cold Weather. When the average daily temperature is below 40° F. (4° C), curing shall consist of covering the newly laid pavement with not less than twelve inches (12") (300mm) of loose, dry hay or straw, or equivalent protective covering authorized by the Engineer, which shall be retained in place for ten (10) days.
1. When concrete is being placed and the air temperature may be expected to drop below 35° F. (1.7° C), a sufficient supply of insulated blanketing material shall be provided along the work, and any time the temperature may be expected to reach the freezing point during the day or night, the material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. The period of time such protection shall be maintained shall be not less than ten (10) days. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

303.18 Removing Forms.

Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has set for at least twelve (12) hours, except auxiliary forms used temporarily in widened areas. Forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated above. Major honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than ten feet (10') (3m) in length nor less than full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than five feet (5') (1.5m) in length shall also be removed and replaced.

303.19 Sealing Joints.

- A. If the joints are to be sealed, they shall be filled with joint-sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and the joint faces shall be clean and surface dry when the seal is applied. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur.
- B. The sealing material shall be applied to each joint opening to conform to the details shown on the plans or as directed by the Engineer. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed, and the pavement surface shall be cleaned. The use of sand or similar material as a cover for the seal will not be permitted. Poured joint-sealing material shall not be placed when the air temperature in the shade is less than 50° F. (10° C), unless approved by the Engineer.

303.20 Protection of Pavement.

- A. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs and lights. He will indicate the location and type of device or facility required to protect the work and provide adequately for traffic.
- B. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protection materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than two inches (2") (50mm) and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall be placing forms against the side of the pavement and covering the surface of the unhardened concrete with the protective covering.
- C. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement shall be replaced.

303.21 Opening to Traffic.

The engineer will decide when the pavement shall be opened to traffic. The pavement shall not be opened to traffic until specimen beams have attained a flexural strength of five hundred and fifty

pounds per square inch (550 psi) (3795kPa), when tested by the third-point method. If such tests are not conducted, the pavement shall not be opened to traffic until fourteen (14) days after the concrete was placed. Prior to being opened to traffic, the pavement shall be cleaned.

303.22 Concrete Pavement - Slipform Method.

Unless prohibited on the plans, pavement may be constructed without the use of fixed forms. When the slipform method is used, the following provisions shall apply:

- A. Grade. After the grade or base has been placed and compacted to the required density, the grade and areas which are to support the paving machine shall be cut to the proper elevation by means of an approved fine-grading machine. The fine-grading machine shall be of sufficient weight, and shall be either self-propelled or towed by sufficient power to trim the compacted material without gouging or tearing the surface. The machine shall have cutting edges or surface shavers controlled from an independent control reference wire by means of an automatic control device. To avoid excessive depths of cut the machine may accomplish the fine grading by means of successive passes with each pass controlled from the independent reference line through the automatic control. If the density of the base is disturbed by the grading operations, it shall be corrected by additional compaction before concrete is placed. The grade shall be constructed sufficiently in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of the placing of the concrete.

- B. Placing Concrete. The concrete shall be placed with an approved slipform paver designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finish will be necessary to provide a dense and homogenous pavement in conformance with the plans and specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibrations shall be accomplished with vibrating tubes or arms working in the concrete, or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur.
 1. The concrete shall be held at a uniform consistency, having a slump of not more than two inches (2") (50mm). The slipform paver shall be operated with as nearly a continuous forward movement as possible, and all operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

DIVISION 300

SECTION 304

ASPHALTIC CONCRETE PAVEMENT

See also and include requirements from
2018 AMENDED SECTION 304

(For discrepancies existing between previous Sections and
Amended Sections, the current Amended Section shall prevail.)

304.01 Description.

The work specified under this section shall consist of one or more courses of bituminous mixture constructed on a prepared foundation and in reasonably close conformity with the lines, grades, thicknesses, and typical cross-sections shown on the plans or established by the Engineer. This article also addresses asphaltic concrete pavement repairs performed as part of the installation of some appurtenance.

304.02 Materials.

- A. General. The asphaltic pavement shall be hot mixed at a central plant. It shall consist of mineral aggregates, uniformly mixed with asphalt cement and laid upon the prepared base to the finished thickness shown on the typical cross-section on the plans or as directed by the Engineer. The composition of the combined mineral aggregate shall be crushed gravel.
- B. Crushed Gravel Gradation. Crushed gravel shall consist of clean, hard, durable, stone particles which have been crushed, screened, and otherwise processed to meet the following requirements. The thickness and grading type shall be as specified in the special provisions.

TABLE - GRADATION REQUIREMENTS

Sieve Size	Percentage Passing by Weight	
	3/4" (20mm) Max. Grading A	1/2" (12.5mm) Max. Grading C
1" (25mm)	100	-
3/4"(20mm)	90-100	100
1/2"(12.5mm)	60-85	90-100
3/8"(9.5mm)	-	60-85
#4 (4.75mm)	40-60	40-60
#8 (2.36mm)	25-45	25-45
#30 (600um)	10-30	10-30
#200 (75um)	2-8	2-8

- C. General. Aggregate shall be composed of coarse and fine aggregates combined in the proper proportions to meet the grading requirements shown above. Aggregates shall be composed of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces and free from fragments coated with dirt or other objectionable matter.

- D. Coarse Aggregate. Coarse aggregate shall be crushed stone or crushed gravel of such gradation that when combined with other required aggregate fractions and fillers in proper proportion, the resultant mixture shall meet the gradation required under the composition of mixture for the specific type under contract. The crushed aggregate shall have a percentage of wear of not more than 40 when tested in accordance with AASHTO T-96. The sodium sulfate soundness loss shall not exceed 12% in accordance with AASHTO T-104 and the plasticity shall not exceed three (3).
- E. Fine Aggregate. Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. The fraction passing the No. 200 (75 μ m) sieve shall not be greater than two-thirds (2/3) of the fraction passing the No. 40 (425 μ m) sieve. The fraction passing the No. 40 (425 μ m) sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than three (3), except that when the plasticity index is non-plastic (NP), the liquid limit shall be not more than 30.
1. When Type II pavement is specified, not less than 50% of the materials by weight, retained on the No. 4 (4.75mm) sieve, shall have at least one fractured face, unless a different percentage of fractured faces is shown on the plans.
 2. When Type III pavement is specified, not less than 50% of the materials by weight, retained on the No. 4 (4.75mm) sieve, shall have at least one fractured face unless otherwise shown on the plans. During crushing operations the coarse aggregate, the pit run minus No. 4 (4.75mm) fine aggregate, and the crushed minus No. 4 (4.75 mm) fine aggregate, shall be stockpiled in separate piles.
 3. Crushed gravel shall show no signs of detrimental stripping when tested in accordance with ASTM D1664 using asphalt taken from the plant. This test shall be performed at the plant owner's expense by an approved testing laboratory once every week of operation. Test results are to be submitted immediately by the testing lab to the City Engineer.
 4. Admixtures and treating methods shall be subject to the special approval of the Engineer. Samples of the proposed admixtures shall be submitted to the Engineer at least two (2) weeks prior to use. Special attention will be given to the thermal stability of admixtures.
- F. Asphalt Cement. The asphalt cement shall be PG 58-28, PG 64-22, or PG 64-28. The grade of asphalt cement shall meet the requirements for the grade and type as stated in the AASHTO Provisional Standards 1993 and AASHTO documents PP5, PP6, PPX, M20, and M226. The type and grade of bituminous material may be changed one step by the Engineer during construction, at no change in unit price. The amount of asphalt cement in the submitted and approved mix formula for Grading "A" and Grading "C", shall be established by Marshall Design Criteria. Initial guideline for the amount of asphalt cement in Grading "A" is 4.5-5.5%, and in Grading "C" is 5-6% by weight.

1. Certificates of compliance for each consignment of asphalt cement shall be furnished by the Contractor to the Engineer in accordance with the requirements of Division 400, Section 403.06 of the specifications.

304.03 Paving Plant Requirements.

A. General Requirements.

1. Uniformity. The plant shall be so designed and operated as to produce a job mixture whose permissible variance from the mix design shall be as follows:

Amount passing on the No. 4 (4.75mm) sieve and larger	+ 7%
Amount passing on the No. 8 (2.36mm) to No. 100 (150 μ m) sieves	+ 5%
Amount passing on the No. 200 (75 μ m) sieve	+ 3%
Asphalt Cement	<u>\pm5%</u>

- i. The range of tolerance shall not exceed the maximum value listed in gradation or asphalt cement requirements.
 - ii. The mixture shall have a density, when thoroughly compressed, of not less than 97% of field sampled laboratory Marshall density.
2. Paving Plant Inspection. For verification of weights or proportions and character of materials, and determination of temperatures used in the preparation of mixture, the Engineer, or his authorized representatives, shall have access at any time to all parts of the paving plant.
 3. Composition of Mixtures. Mixing temperatures for bituminous mixes shall be determined by the submitted and approved mix design.

Grade of Material
PG 64-22

Typical Applications
ALL TYPES OF CONSTRUCTION

- B. Asphaltic Pavement Mixture Design Criteria. The following Marshall Design Criteria shall be used to determine optimum asphalt content:

1. No. of Compaction Blows Each End of Specimen - 50.

<u>Test Property</u>	<u>Min.</u>	<u>Max.</u>
Stability, all mixtures (lbs.) (kg)	1200(540)	---
Flow, all mixtures (in.) (mm)	.08(2mm)	.16(4.5mm)
Air voids (%)	3	5

304.04 Construction.

A. General Conditions.

1. Proofrolling. Prior to the placing of any hard surfacing material upon the subgrade/subbase/base, such subgrade/subbase/base shall be proofrolled under the observation of a representative of the City Engineer's Office and approval obtained. The proofrolling shall be done by a pneumatic tired roller with tires having a ground contact pressure of 85-90 p.s.i. (585-621 kPa). The entire area upon which hard surfacing is to be placed must be rolled. When proofrolling shows an area to be unstable, such area shall be brought to satisfactory stability by additional compaction, reworking, or removal of unsuitable material and replacement with acceptable material. If paving operations have not begun within twenty-four (24) hours after approval, a repeat of the proofrolling may be required.
2. Weather Limitations. Bituminous plant mix shall not be placed on any wet surface or when the atmospheric temperatures are less than those specified in the following table; or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

Atmospheric Temperature Limitations

<u>Compacted Thickness</u>	<u>Surface Course</u>	<u>Subsurface Course</u>
Less than 1" (25mm)	60° F (15.5°C)	55° F (13°C)
1" to 2", (25-50mm) inclusive	40° F (4.5°C)	35° F (1.7°C)
More than 2" (50mm) to and including 4" (100mm)	35° F (1.7°C)	35° F (1.7°C)
More than 4" (100mm)	N/A	25° F (-4°C)

- i. The meanings of the terms "surface course" and "subsurface course" applies to this subsection only, and shall be as follows:
 - a. Any plant mix pavement overlaid with surface course on the same contract is considered a subsurface course.
 - b. Plant mix bituminous base is considered a subsurface course.
 - c. Spot leveling or the bottom lift of a leveling course may be placed at 35° F (1.7°C) if additional courses are placed on the same contract.

- d. Surface course shall be Grading "C" aggregate.
 - e. Subsurface course shall be Grading "A" aggregate.
- B. Transportation of Mixture. The mixture shall be transported from the paving plant to the work in vehicles equipped with tight metal compartments previously cleaned of all foreign materials. When directed by the Engineer, the compartments shall be suitably insulated and each load shall be covered with canvas or other suitable materials of sufficient size to protect it from weather conditions. The inside surface must be lightly lubricated with a non-stick lubricant just before loading, but excessive lubricant will not be permitted. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight.
- C. Placing Asphalt Mixture. The mixture shall be delivered on the work site at a temperature plus or minus 15° F. (-9°C) of the mixing temperature, but in no case shall the temperature be below 240° F. (156°C). Final rolling and density of the bituminous surface, subsurface, or leveling courses must be obtained prior to the mixture reaching a minimum temperature of 180° F (82°C).
1. Unless otherwise permitted by the Engineer, the mixture shall be spread by means of a mechanical self-powered paver, capable of spreading the mixture true to the line, grade, and crown shown on plans. Hand-placing and spreading will be permitted in irregular areas where it is impractical to use a paving machine.
 2. Pavers shall be equipped with hoppers and distributing screws of the reversing type to place the mixture evenly in front of adjustable screeds. The mixture shall be dumped in the center of the hoppers and care exercised to avoid overloading and spilling over the mixer upon the base. Pavers shall operate, when laying mixtures, at such speed for a consistent and uniform laying of the mixture as may be decided by the Engineer.
 3. Pavers shall be equipped with a quick and efficient steering device and shall have forward and reverse traveling speeds of not less than one hundred feet (100') (33m) per minute and a tamping device capable of delivering at least 500 blows per minute.
 4. Unless operating on fixed side forms, pavers shall employ mechanical devices such as equalizing runners, straight-edge runners, evener arms, or other compensating devices to adjust the grade and confine the edges of the mixtures to true lines without the use of stationary side forms. The pavers shall be capable of spreading the mixtures, without segregation, in thickness of from one-half inch (1/2") (12.5mm) to three inches (3") (75mm) and in widths of eight feet (8') (2.5m) to fourteen feet (14') (4.5m) adjustable in steps of one foot (1') (.3m) or less. They shall be equipped with blending or joint leveling devices for smoothing and adjusting all longitudinal joints between adjacent strips of courses of the same thickness.

5. Pavers shall be equipped to automatically control the laying of the mixture to specified transverse slope and established longitudinal grade. The paver control system shall be automatically actuated from an independent line and grade control reference through a system of mechanical sensors and sensor-directed devices which shall maintain the paver screed at the proper transverse slope and height to establish the top surface of the compacted mixture at specified slope and grade.
6. The screed or "strike-off" assembly shall produce the specified finished surface without tearing, shoving, or gouging, and which produces a finished surface of the evenness and texture specified. The screed shall be adjustable as to level and shall have an indicating level attached and shall be vibrating.
7. Immediately after any course is screeded, and before roller compaction is started, the surface shall be checked, and all inequalities adjusted. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is rolled.
8. The Contractor shall provide a competent worker who is capable of performing the work incidental to the correction of all pavement irregularities. Special attention shall be given by the worker to the straight-edging of each course immediately following the initial rolling.
9. In narrow, deep, or irregular sections, intersections, turnouts, or driveways where it is impractical to spread and place asphalt mixes by machine methods, the Contractor may use approved spreading equipment or acceptable hand methods as directed by the Engineer. Excessive loose rock will be removed from surface prior to rolling the patch.
10. When the mixture is to be spread by hand, upon arrival on the work it shall be dumped outside the area on which it is to be spread, or shoveled directly from the truck to the area on which it is to be spread. Immediately thereafter it shall be distributed into place by means of hot shovels and spread with hot rakes in a loose layer of uniform density and correct depth. Tines of the rakes shall be not less than one-half inch (1/2") (12.5mm) longer than the loose depth of mixture and spaces between tines shall be not less than the maximum diameter of aggregate particle except that in no case should the spaces be less than one inch (1")(25mm). Loads shall not be dumped any faster than they can be properly handled by the shovelers. Lutes may be used with permission of the Engineer.
11. The shovelers shall not distribute the dumped load faster than it can be properly handled by the rakers.
12. The rakers will not be permitted to stand in the hot mixture while raking it, except where necessary to correct errors in the first raking. The raking must be carefully and skillfully done in such a manner that after the first passage of the roller over the raked mixture, a minimum amount of back patching will be required.

13. The placing of the mixture shall be as continuous as possible. The roller shall pass over the unprotected edge of the freshly laid mixture only when the laying of this course is to be discontinued for such intervals of time as to permit the mixture to become chilled.

D. Joints. Transverse construction joints shall be made in a careful manner. The edge of the previously laid course shall be cut back as far as is necessary to eliminate irregularities incidental to finishing and rolling. After laying the finished mixture adjacent to a transverse construction joint, a skilled laborer shall follow up each rolling with a straightedge and corrective measures to insure a smooth riding surface. The laborer shall be equipped with hot smoothing irons, tampers, and other devices for use in truing up the pavement surface adjacent to the joint.

1. Longitudinal joints against both hot and cold material shall be made with equal care. Mixtures spread and compacted (or partially compacted) by the machine shall not be disturbed by a rake in dressing the joint, unless one side is too high, nor shall surplus mixture be spread or scattered back of the machine when not needed to build up low spots. When spreading next to a warm or cold edge of a previously laid section of surfacing, the machine shall be adjusted to leave a "bead" of material, roughly one inch (1") (25mm) by one inch (1") (25mm), which shall be rolled in to compensate for uneven density at the joint. If one side of the joint is cold, the "bead" shall be moved back of the rake to the warm side of the joint but otherwise the machine-laid mixture shall not be disturbed.

2. In making the joint along any adjoining edge such as curb, gutter, or an adjoining pavement, and after the hot mixture is placed by the finishing machine, just enough of the hot material shall be carried back to fill any space left open, and provide a small "bead" of extra material. This joint shall be properly "set-up" with the back of the rake at proper height and bevel to receive the maximum compression under rolling. The work of "setting-up" this joint shall always be performed by competent workmen, who are capable of making a correct, clean, and neat joint.

E. Bonds Between Existing and New Asphalt.

1. In order to obtain a good bond between existing and new asphalt pavements, all areas where the existing pavement is cut for the installation of an appurtenance or structure the Contractor shall saw cut the full depth of the existing asphalt pavement a minimum of twelve inches (12") (300mm) beyond the excavation. This entire edge will be properly coated with tack oil prior to the installation of the new asphalt pavement. The new pavement section will be applied in two (2) lifts. In addition, as directed by the Engineer, after the first lift is applied, the edge of the old asphalt pavement shall be milled down to the level of the first lift of the new pavement section or a minimum of one and one-half (1½") (37.5mm) from the surface. The milling shall extend at least

twelve (12”) (300mm) beyond the saw cut. The milled surface shall be thoroughly cleaned and have tack oil applied to it and coated to cover the entire edge before applying the second lift. The second lift will then be applied overlapping the milled surface and the new first lift of the new pavement. If the second lift cannot be applied immediately after compaction of the first, the first lift shall have tack applied to its surface before the application of the second.

- F. Compaction of the Mixture. As soon as the mixture will carry the compaction equipment without undue shoving or displacement, it shall be compacted with self-propelled rollers. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted.

Recommended criteria:

1. Three-axle tandems, two-axle tandems, and three-wheeled rollers used for breakdown rolling shall be of such weight that the compression load on the drive wheels is at least three hundred twenty five pounds per inch (325#/in) (58kg/cm) of tire width.
2. Vibratory rollers used for breakdown or intermediate rolling having a compactive effort of not less than a dynamic force of twenty one thousand pounds (21,000#)(9525kg) may be used only with the written consent of the City Engineer, and should not be used on lifts of two inches (2”) (50mm) or less.
3. Two-axle tandem rollers used for intermediate and finish rolling shall weigh not less than seven tons (7 t) (6350kg).
4. Pneumatic-tired rollers used for intermediate rolling shall be the oscillating type having a width of not less than four feet (4') (1.2m) and equipped with pneumatic tires of equal size and diameter, having treads satisfactory to the Engineer. Wobble-wheel rollers will not be permitted. The tires shall be so spaced that the gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to ninety pounds per square inch (90 psi) (621 kPa) or such lower pressure as designated by the Engineer, and maintained so that the air pressure will not vary more than five pounds per square inch (5 psi) (35 kPa) from the designated pressure. Pneumatic-tired rollers shall be so constructed that the total weight of the roller can be varied to produce an operating weight per tire of not less than two thousand pounds (2,000#) (900kg). The total operating weight of the roller shall be varied as directed by the Engineer.
 - i. Other rollers may be used subject to prior approval by the Engineer.
5. All rollers must be maintained in good mechanical condition, and those that cannot be driven along a straight path or operated without jerking, shall not be used. No leakage of petroleum products from any roller shall be allowed to come in contact with pavement being constructed, nor shall any roller be permitted to stand motionless on any

portion of the work. The surfaces of all roller wheels shall be misted with sufficient water to prevent the pickup of bituminous materials, but under no circumstances shall the quantity of water used be detrimental to the surface of the pavement being rolled. Water shall not be applied directly in any manner to the asphalt surface.

6. As soon as the layer of asphalt concrete has been placed, it shall be thoroughly compacted by rolling. Except when compacting lifts greater than four inches (4") (100mm) in compacted thickness, rolling shall be commenced along the lower edge of the area to be rolled and continued until the edge is thoroughly compacted, after which the roller shall be gradually advanced to the crown point, both sides being rolled in like manner. Rolling shall be continued until the pavement layer has become thoroughly compacted throughout and is true to grade and cross-section.
 7. For lifts greater than four inches (4") (100mm) in compacted thickness, rolling shall be commenced in the middle of the mat, after which the roller shall be gradually advanced to both edges. The roller should be advanced to a supported edge first, if applicable. Rolling of an unsupported edge should be delayed as long as possible, provided the required densities are obtained after the completion of the finishing rolling.
 8. The finish rolling of the surface course shall be done with a tandem steel-wheeled roller until all roller marks are eliminated.
 9. Along curbs, headers, manholes, and similar structures, and at all places not accessible to the roller, thorough compaction must be secured by means of hot tampers and irons. At all contacts of this character, the joints between these structures and the surface mixture must be effectively sealed with a bituminous tack coat.
 10. After final compression, the surface course shall conform with the following requirements:
 - i. It shall be smooth and true to the established crown and grade. It shall have the average thickness specified and shall at no point vary more than one-fourth inch (1/4")(6.25mm) from the thickness shown on the typical cross-sections on the plans. Any low or defective places shall immediately be remedied by cutting out the course at such spots and replacing it with fresh, hot mixture which shall be immediately compacted to conform with the surrounding areas and shall be thoroughly bonded to it. The surface of the finished pavement shall be free from depressions exceeding one-fourth inch (1/4")(6.25mm) as measured with a ten foot (10') (3m) straight edge in any direction.
 11. At no point shall the density of the binder and surface course be less than 97% of maximum Marshall density. (See Division 400, Section 402.03.)
- E. Construction Testing and Sampling. All testing and sampling shall be done in accordance with the latest A.A.S.H.T.O. methods unless otherwise specified. Test results shall be

forwarded immediately by the testing lab to the City Engineer and general Contractor. The frequency of all required testing may be increased or decreased at any time deemed necessary by the City Engineer. The following tests shall be required during construction.

1. Asphalt Content and Gradation. One asphalt content and gradation test shall be made per each four hundred tons (400 t) (363 metric t) or portion thereof of asphaltic mixture placed per day. These tests shall be performed on samples taken prior to screeding. The percentage of asphalt content may be determined by Ignition Oven or by Extraction Method (ASTM D 2172, D 6307, ASHTO T164).
 1. Marshall Series. A complete Marshall test series shall be performed each week of paving operations when placing more than four hundred tons (400 t) (363 metric t).
 2. Density Tests. At least one (1) density test for each four hundred tons (400) (363 metric t) or part thereof shall be performed for each two hundred feet (200') (61m) of paving strip.
 3. Preconstruction Test and Sampling. All sampling and testing of materials shall be done in accordance with the latest A.A.S.H.T.O. methods unless otherwise specified. At least three (3) weeks in advance of the beginning of asphaltic paving work, the Contractor shall:
 - i. Submit suitable samples of all materials including asphalt cement to an approved materials testing laboratory for mixture design, and to determine compliance of materials to these specifications;
 - ii. Or shall submit certification that the materials to be used are in conformance with these specifications and that the mixture design for use with these materials is approved and on file with the City Engineer.
 4. The Contractor shall be responsible for all preconstruction tests and sampling, Marshall series testing, and all asphalt content and gradation testing. The Contractor shall select and pay for a certified testing firm, acceptable to the Owner and Engineer.
 5. Unless specified by the contract documents or Standard Specifications the Owner/Engineer will be responsible for all density/moisture testing. If the initial test fails to meet minimum requirements, the Contractor shall pay for any and all additional tests until the minimum density/moisture standards are met.
- H. Warranty or Inspection of Asphaltic Concrete Pavement. After completion of the asphalt and concrete work and prior to the end of the specified warranty period, the City will inspect all asphalt and concrete areas installed on this project. At the time of the inspection, all areas of asphalt where there exists a one quarter inch (1/4") (6 mm) separation between the new asphalt and the existing asphalt or the new asphalt and the new concrete, the Contractor will be required to crack seal these locations following City specifications. The sealant shall conform to ASSHTO M 301 or

modified ASTM D 3405. Any pavement found to have settled more than one-quarter inch (1/4") (6mm) shall be repaired as to the engineer's recommendations.

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DIVISION 400

SECTION 401

PAVEMENT SUBBASE COURSE

See also and include requirements from
2018 AMENDED SECTION 401

(For discrepancies existing between previous Sections and
Amended Sections, the current Amended Section shall prevail.)

401.01 Description.

The work covered by this Section shall consist of furnishing, placing, watering, shaping, and compacting a course of crushed stone or crushed gravel, and an approved soil binder or natural filler, to provide a firm and stable foundation for subsequent construction. The subbase course shall be constructed on a previously prepared subgrade in accordance with the requirements in these Specifications and the typical cross-section shown on the plans.

401.02 Materials.

- A. General. Before production of any of the following materials, all vegetation and stripping material shall be removed from the pit. Only designated portions of the pit will be used. The composite materials shall be free from clay balls, vegetable matter, and other deleterious substances, and shall not contain an excess of thin or elongated pieces.
- B. Crushed subbase shall be crushed stone or crushed gravel and an approved soil binder or natural filler, where required, conforming to the following requirements, unless otherwise designated on the plans or in the special provisions.
 1. Course aggregate shall consist of hard, durable particles, or fragments of stone or gravel. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used. Unless otherwise specified, the coarse aggregate shall have a percentage of wear of not more than 50.
 2. Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. The fraction passing the No. 200 (75 μ m) sieve shall not be greater than two-thirds (2/3) of the fraction passing the No. 40 (425 μ m) sieve. The fraction passing the No. 40 (425 μ m) sieve shall have a liquid limit not greater than twenty five (25) and a plasticity index not greater than six (6) except that, when the plasticity index is non-plastic, the liquid limit shall not be more than thirty (30).
 3. Crushed base shall meet one of the following gradation requirements, or as specified by the drawings:

Sieve Designation	Grading D	Grading G	Grading H	Grading J	Grading K	Grading W
2"(50mm)	100	100	-	100	-	-
1 1/2"(37.5mm)	95-100	95-100	-	95-100	100	100
1"(25mm)	-	-	100	-	95-100	95-100
3/4" (20mm)	-	-	95-100	-	-	-
#4 (4.75mm)	50-85	-	45-65	35-75	40-65	45-65
#8 (2.36mm)	40-70	-	33-53	-	30-55	33-53
#200 (75 μ m)	2-15	0-15	3-12	0-15	3-15	3-12

C. Subbase shall be crushed stone or gravel meeting the wear, liquid limit, plasticity index and gradation requirements specified for crushed subbase.

D. Crusher run subbase shall be crushed material of the maximum size as called for on the plans or Special Conditions.

401.03 Subgrade Preparation.

The subgrade shall be prepared in accordance with Division 200, Section 201 of these Specifications. Immediately prior to placing the subbase material, the subgrade shall be true to line and grade and shall be smooth, dense, and free from ruts, depressions, and irregularities. The subbase course shall not be placed until the subgrade has been approved by the Engineer.

401.04 Placing.

The subbase course material shall be placed on previously prepared subgrade at the locations and in the proper quantities to conform to the typical cross- sections as shown on the plans and directed by the Engineer. The subbase material shall be placed in lifts not exceeding four inches (4") (100mm) in final thickness. Placing and spreading shall be done by means of spreading machines, motor graders, or any other approved equipment and methods. The method of spreading and placing shall be such that segregation of the coarse and fine particles is avoided. If undue segregation occurs the method of spreading and placing shall be modified so that the placement is made to the satisfaction of the Engineer.

401.05 Laying and Compacting.

A. After the subbase course material has been placed and uniformly spread over the prepared subgrade, compaction shall be accomplished by means of multiple-wheel pneumatic-tired rollers, tandem or three-wheel steel rollers and/or vibratory compactors, or any other method approved by the Engineer. If additional water is needed to facilitate compaction and bonding of the materials, it shall be applied at the direction of the Engineer.

- B. Rolling shall be continued until the subbase material has been compacted to a density of at least 95% minimum dry density as determined by the ASTM Standard Test Method D698 and a moisture content of $\pm 2\%$ of optimum.
- C. The finished subbase surface shall be smooth and free from ruts and irregularities and true to grade and crown as shown by the plans or as directed by the Engineer. Tolerance and smoothness shall be as specified in Division 200, Section 201.03. Any deviations in excess of these amounts shall be corrected by loosening, adding, or removing materials, reshaping, and recompacting by wetting and rolling. The subbase course, material shall be maintained in this condition by watering, rolling, or blading as the Engineer may direct until the base course is applied.

401.06 Quality Control.

- A. Preconstruction Testing. All testing and sampling shall be done in accordance with the latest ASTM methods unless otherwise specified. At least two weeks in advance the Contractor shall:
 - 1. Submit suitable samples of the subbase material to an approved materials testing laboratory for tests to determine the compliance of the proposed subbase material with these specifications;
 - 2. Or shall submit certification that the subbase materials to be used are in accordance with these Specifications.
- B. Construction Testing. Prior to and during construction, the supplier/Contractor shall have performed by an approved and certified testing laboratory, one gradation test including L.L. and P.I. per each two thousand square yards (2,000 sq.yds.) (1,675 sq.m.) placed, or portion thereof. Copies of the results of such tests shall be forwarded by the lab to the Engineer, Contractor, and/or owner.

DIVISION 400

SECTION 402

PAVEMENT BASE COURSE

See also and include requirements from
2018 AMENDED SECTION 402

(For discrepancies existing between previous Sections and
Amended Sections, the current Amended Section shall prevail.)

402.01 Description.

The work covered by this Section shall consist of furnishing, placing, watering, shaping, and compacting a course or courses of crushed gravel to provide a firm and stable foundation for subsequent construction. The base course shall be constructed on a previously constructed subbase or subgrade in accordance with the requirements of these specifications and in conformity with the lines, grades, quantity requirements, and the typical cross-sections shown on the plans.

402.02 Materials.

- A. Crushed Gravel. The crushed gravel for base course shall consist of clean, hard, durable particles which have been crushed to the following gradations:

<u>Sieve Size</u>	<u>% Passing by Weight</u>	
	<u>Grading W</u>	<u>Grading H</u>
1 1/2" (37.5mm)	100	
1" (25mm)	90-100	100
1/2" (12.5mm)	60-85	95-100
#4 (4.75mm)	45-65	45-65
#8 (2.36mm)	33-53	33-53
#200 (75um)	3-12	3-12

1. The above is equivalent to Wyoming Highway Department grading "W" or grading "H" base course. The type of base course to be applied shall be specified in the special provisions.
2. Coarse aggregate shall consist of hard, durable particles, or fragments of stone or gravel. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used. Unless otherwise specified, the coarse aggregate shall have a percentage of wear of not more than 50%.
3. Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. The fraction passing the No. 200 (75um) sieve shall not be greater than two-thirds (2/3) of the No. 40 (425um) sieve. The fraction passing the No. 40 (425um) sieve shall have a liquid limit not greater than twenty-five (25) and a plasticity index not greater than six (6) except that, when the plasticity index is non-plastic, the liquid limit shall not be more than thirty (30).

4. Of the particles retained on a No. 4 (425 μ m) sieve, at least 35% by weight shall have one (1) or more broken faces.
- B. Preconstruction Testing. All testing and sampling shall be done in accordance with latest ASTM methods, unless otherwise specified. At least two (2) weeks in advance of the beginning of base work, the Contractor shall:
1. Submit suitable samples of the base material to an approved materials testing laboratory for tests to determine the compliance of the proposed subbase material with these Specifications;
 2. Or shall submit certification that the materials to be used are in conformance with these Specifications.
- C. Construction Testing. During construction the supplier/Contractor shall have performed by an approved testing laboratory one (1) gradation test including liquid limit and plasticity index per each five thousand tons (5,000t) (4500 metric t) or portion thereof, of base material.
1. The results of such tests shall be submitted by the lab to the Engineer, Contractor, and owner.

402.03 Mixing.

- A. The crushing plant shall be equipped with rolls, or any combination of rolls, jaws, or other crushing devices, which will produce the required material. Care shall be exercised in the operation of loading, hauling, and distributing the crushed material to avoid segregation of the coarse and fine particles of the total material. If segregation occurs, the method of spreading and placing shall be modified so that placement is made to the satisfaction of the Engineer. The base course shall be placed on the previously prepared subbase or base course in the proper quantities to conform to the typical cross-section shown on the plans. The crushed material shall then be windrowed and watered as directed by the Engineer and mixed until a uniform mixture is obtained.
1. The base course thickness specified by the plans is absolute minimum thickness. Where the subbase has been left low, the Contractor may, at his option, use base course material as covered in this section of specifications to bring the subbase up to the grade specified.
 2. The Contractor shall mix the aggregate, water, and commercial additive where required, by the stationary plant methods unless otherwise shown on the plan or approved by the Engineer. The moisture content of the material at the time of compaction shall be within +2 or -4 percentage points of optimum.

- B. Stationary Plant Method. The aggregate and water shall be mixed in an approved pugmill mixer. Water shall be added during the mixing operation in the amount necessary to maintain the required moisture content for compacting.
1. The mixer shall be capable of uniformly distributing the aggregate, additives, and water throughout the mixture without evidence of overwet or dry pockets of material when the equipment is operated at the Contractor's desired capacity.
 2. After mixing, the material shall be transported to the job site while it contains the proper moisture content, and shall be placed on the roadbed by means of an approved aggregate spreader.
 3. The spreader shall be capable of spreading the material for a minimum width of ten feet (10') (3m) when used to full capacity to a uniform thickness.
- C. Travel Plant Method. After the material for each layer has been placed through an aggregate spreader, window sizing device or aggregate hopper, the material shall be uniformly mixed by a traveling mixing plant. During mixing, water shall be added in an amount sufficient to maintain the required moisture content for compacting.
- D. Road Mix Method. After material for each layer of the course has been placed, the materials shall be mixed while in the range of +2 or -4 percentage points of optimum moisture content, by means of motor graders or other approved equipment until the mixture is uniform throughout.
- E. Stockpile Method. Commercial additives, if required, will be introduced into the aggregate during stockpiling operations. Water will be introduced by pre-wetting the stockpile of aggregate and additive. Additional water may have to be introduced during the placing of the aggregate courses.

402.04 Shaping and Compaction.

- A. After the base course material has been placed and uniformly spread over the prepared subbase, compaction shall be accomplished by means of multiple-wheel, pneumatic-tired rollers, tandem or three-wheel steel rollers and/or vibratory compactors, or any other method approved by the Engineer. If additional water is needed to facilitate compaction and bonding of materials, it shall be applied at the direction of the Engineer. Rolling shall be continued until the entire base course has been compacted to the required density and moisture content.
1. The finished base surface shall be smooth and free of ruts and irregularities and true to grade and crown and thickness as shown by the plans or directed by the Engineer.
 2. Each layer shall be compacted to a density of not less than 95% of maximum density and a moisture content of plus or minus 2% of optimum moisture, as determined in

accordance with ASTM D698, unless otherwise called for on the plans. Compactions or field-in-place densities will be determined by sand cones or nuclear density meters. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture and surface is produced and the aggregates firmly keyed. Water shall be uniformly applied over the materials during compaction in the amount necessary for proper consolidation.

3. If the required compacted depth of subbase course exceeds six inches (6")(150mm), the course shall be constructed in two or more layers of approximately equal thicknesses. The maximum compacted thickness of any one layer shall not exceed six inches (6")(150mm). When vibrating or other approved types of special compacting equipment are used, the depth of a single layer of the course may be increased upon approval by the Engineer.

402.05 Quality Control Testing.

- A. One density and moisture test shall be performed for every two thousand square yards (2,000 sq.yds) (1675 sq.m) of base course placed.
- B. Gradation tests, including liquid limit and plasticity index shall be performed for every two thousand square yards (2,000 sq.yds) (1,675 sq.m.) placed, or portion thereof.
- C. The Contractor/Supplier shall select and pay for a certified testing firm, acceptable to the Owner and Engineer to complete all gradation, liquid limit and plasticity index testing requirements, prior to and during construction. The lab shall forward copies of the results of such tests to the Engineer, Contractor, and/or Owner.

DIVISION 400

SECTION 403

BITUMINOUS PRIME COAT

See also and include requirements from
2018 AMENDED SECTION 403

(For discrepancies existing between previous Sections and
Amended Sections, the current Amended Section shall prevail.)

403.01 Description.

This Section covers work necessary to prepare and treat an existing surface with bituminous material, if required, in accordance with these specifications.

403.02 Surface Preparation.

Prior to placing the bituminous prime coat, the base course shall be smooth, free from ruts, irregularities, and true to line and grade. All base courses shall be approved by the Engineer before the prime coat is placed. The base surface shall be cleaned to remove all loose or foreign material. The base course surface shall be moderately moist but shall not contain any free or ponded water.

403.03 Materials.

The asphaltic oil for prime coat shall be MC-70 or as specified in the contract documents, and shall meet the requirements of A.A.S.H.T.O. Standard Specification M-82, Table 1.

403.04 Weather Limitations.

Unless otherwise specifically directed by the Engineer no prime coat shall be placed when the atmospheric temperature is less than 50° F. (10° C) ambient, or when in the opinion of the Engineer, excessive wind or other atmospheric conditions will not permit satisfactory placement of the prime coat.

403.05 Application.

- A. The prime coat shall be placed by means of an approved pressure distributor. The distributor shall be in good mechanical condition and shall be capable of uniformly distributing the prime coat throughout a reasonable range of widths, pressures, temperatures, and application rates. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices, and an accurate thermometer for reading temperatures of tank contents. The prime coat shall be applied at a rate of not less than 0.20 gals./sq. yd. (0.9l/sq.m) nor more than 0.50 gals./sq. yd (2.3l/sq.m) as directed by the engineer. Temperature at application shall be between 90° F. (32° C) and 180° F (82° C). The prime coat shall be carefully and uniformly applied, particularly around curbs, sidewalks, and other structures, and if excessive amounts of asphaltic oil are sprayed on the curbs, sidewalks, and other structures, they shall be cleaned as directed by the Engineer at the Contractor's expense. Excessive lapping of abutting applications will not be permitted. Should excessive lapping occur, the

prime coat in the lapped portion shall be removed and replaced as directed by the Engineer at the Contractor's expense.

- B. All spots missed by the distributor or areas which are inaccessible to the distributor shall be handsprayed. Particular attention shall be given to handspraying operations to avoid the application of excessive amounts of asphaltic oil.
- C. The primed surface shall be allowed to cure for at least twenty-four (24) hours before placing any bituminous pavement. The primed surface shall be maintained by the Contractor until the bituminous pavement is placed. Any damaged areas shall be repaired as directed by the Engineer and at the Contractor's expense. All vertical contact surfaces such as concrete gutters, manholes, drainage structures, curbs, and so forth shall be primed by painting with hot asphaltic cement of the same grade being used in the asphaltic pavement just prior to placing the asphaltic pavement.

403.06 Quality Control.

A test report shall be obtained from the vendor by the Contractor at the time of shipment of each consignment of asphaltic material. This test report shall be submitted to the Engineer for approval prior to application or use of any asphaltic material in the work. The test report shall show loading temperature, quantity in weight, quantity in gallons at 60° F (15.5° C), viscosity, A.P.I. or specific gravity at 60° F (15.5° C), characteristics of residue and distillation ends of the material contained in the consignment, and percent and type of additive included when specified.

DIVISION 400

SECTION 404

BITUMINOUS TACK COAT

See also and include requirements from
2018 AMENDED SECTION 404

404.01 Description. (For discrepancies existing between previous Sections and Amended Sections, the current Amended Section shall prevail.)

This work described in this Section shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material. Application of tack coat material shall be as specified in the contract documents.

404.02 Surface Preparation.

Prior to placement of the bituminous tack coat, the pavement surface shall be clean, dry, and free of all loose and foreign material. All pavement surface shall be approved by the Engineer before the tack coat is placed.

404.03 Materials.

The bituminous oil for tack coat shall meet the requirements of A.A.S.H.T.O. Specification M81, Table 1, or emulsified asphalt, SS-1, or SS-1h diluted approximately one to one with water and meeting the requirements of A.A.S.H.T.O. Specification M-140.

404.04 Weather Limitations.

Unless otherwise specifically directed by the Engineer, no tack coat shall be placed when the ambient air is below 40° F. (4.4°C), or when, in the opinion of the Engineer, excessive wind or other atmospheric conditions will not permit satisfactory placement of the tack coat.

404.05 Placing of the Tack Coat.

- A. The tack coat shall be placed by means of an approved pressure distributor. The distributor shall be in good mechanical condition and shall be capable of uniformly distributing the tack coat throughout a reasonable range of widths, pressures, temperatures, and application rates. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices, and an accurate thermometer for reading temperatures of tank contents. The tack coat shall be applied at a rate of .06-.1 gals./sq. yd (.27 - .45liters/sq.m). Prior to placement SS-1 and SS-1h shall be heated to 75°-130°F (24 - 55°C). Care should be taken not to exceed the upper limits of these ranges.
- B. The tack coat shall be carefully and uniformly applied, particularly around curbs, sidewalks, and other structures, and if excessive amounts of bituminous oil are sprayed on the curbs, sidewalks, and other structures, they shall be cleaned as directed by the Engineer at the

expense of the Contractor. Excessive lapping of abutting applications will not be permitted. Should excessive lapping occur, the tack coat in the lapped portion shall be removed and replaced as directed by the Engineer at the Contractor's expense.

- C. All spots missed by the distributor or areas which are inaccessible to the distributor shall be handsprayed. Particular attention shall be given to handspraying operations to avoid the application of excessive amounts of bituminous oil.
- D. The tacked surface shall be allowed to cure before placing any asphaltic concrete. The tacked surface shall be maintained by the Contractor until the asphaltic concrete is placed. Any damaged areas shall be repaired as directed by the Engineer and at the Contractor's expense. All vertical contact surfaces such as concrete gutters, manholes, drainage structures, curbs, and so forth, shall be tacked by painting with a hot asphaltic cement of the grade used in the asphaltic pavement just prior to placing the asphaltic pavement.
- E. When the first course of asphaltic concrete is to be immediately covered by the second course of asphaltic concrete, the tack coat may not be required. When the first coat of asphaltic concrete is subjected to traffic, rain, blowing dust, and other unfavorable conditions, the tack coat shall be applied.

404.06 Test Reports.

Certificates of compliance for the bituminous tack coat material shall be supplied by the Contractor and furnished to the Engineer for each consignment of asphaltic material as provided Division 400, Section 403.06 of these Specifications.

DIVISION 400

SECTION 405

BITUMINOUS SEAL COAT (CHIP SEAL)

NO LONGER USED BY THE CITY OF CASPER.

DIVISION 400

SECTION 406

BITUMINOUS SLURRY SEAL SPECIFICATIONS

406.01 Description

This Section covers the furnishing and installation of a Slurry Seal. The Slurry Seal shall consist of a mixture of an approved modified asphalt, mineral aggregate, water, specified additives, proportioned, mixed and uniformly spread over a properly prepared surface as directed by the Engineer. The completed slurry seal shall leave a homogeneous mat, adhere firmly to the prepared surface, and have a high friction surface texture throughout its service life.

406.02 Materials

A. Emulsified Asphalt

1. Emulsified Asphalt shall be a Quick Set Mixing Grade as specified in ASTM D977, or D2397, AASHTO M140 or M208 depending on aggregate selected for the Job Mixture.
2. Grade shall be determined from proposed mix design supplied by the Contractor.

i. Quality Tests

<u>Quality</u>	<u>Reference</u>	<u>Limits</u>
Residue after Distillation	AASHTO T59, ASTM D244	60% min.
Test On Residue Penetration at 77°F (25° C)	AASHTO T49, ASTM 2397	40-100

3. Each load of Emulsified Asphalt shall be accompanied by certification of compliance from the manufacturer for assurance that it is the same as used in the Mix Design.

B. Aggregate

1. General. Mineral Aggregate shall be 100% crushed rock. Aggregate shall be clean, hard, sound, durable, uniform in quality and free from any detrimental quality of soft, disintegrated material, organic material, oil, alkali or other deleterious substance. In order to insure that all material is crushed, 100% of the parent material shall be larger than the largest stone in the gradation used.

2. Quality Tests.

<u>Quality</u>	<u>Reference</u>	<u>Limits</u>
Sand Equivalent	AASHTO T176, ASTM D2419	45 min.
Soundness	AASHTO T104, ASTM C88	15% max. using Na ₂ SO ₄ or 25% max. using MgSO ₄
Abrasion Resistance	AASHTO T96, ASTM C131	35% max.

- i. The abrasion test shall be run prior to crushing the aggregate.
 - ii. Aggregate shall meet approved polishing values.
2. Gradation. When tested in accordance with AASHTO T27 (ASTM C136) and AASHTO T11 (ASTM C117) the total aggregate blend including mineral filler shall be within the appropriate band.

	TYPE I	TYPE II	TYPE III	
Sieve Size	% Passing	% Passing	% Passing	Stockpile Tolerance
3/8" (9.5mm)	100	100	100	-----
#4 (4.75mm)	100	90-100	70-90	± 5%
#8 (2.36mm)	90-100	65-90	45-70	± 5%
#16 (1.18mm)	65-90	45-70	28-50	± 5%
#30 (600um)	40-65	30-50	19-34	± 5%
#50 (330um)	25-42	18-30	12-25	± 4%
#100 (150um)	15-30	10-21	7-18	± 3%
#200 (75um)	10-20	5-15	5-15	± 2%

- i. The target job mix gradation for the Mix Design shall fall within the appropriate band. Deviation from the appropriate band must be approved by the Engineer. Once the target job mix gradation has been submitted and approved as part of the Mix Design, gradation of aggregate used throughout the Project shall not vary from the

approved gradation more than the stockpile tolerances for each sieve and shall remain within the gradation band.

- ii. Aggregate will be accepted at the job site or stockpile. Stockpiled aggregate shall be accepted on the basis of five (5) gradation tests performed according to AASHTO T2 (ASTM D75). Materials will be accepted if an average taken from all five (5) tests falls within the gradation tolerances. In the case where the averaged test results proves to be out of tolerance, the Contractor shall either remove the unacceptable material and replace it with acceptable material or blend other aggregate with the stockpiled material to bring it into gradation tolerances. New materials to be used in blending shall meet all quality tests prior to blending. Blended aggregate shall produce a consistent mix. In either case, whether aggregate is replaced or blended, a new Mix Design shall be submitted to the Engineer for approval.
- iii. Stockpiles shall be screened if problems in application occur due to oversize material in the mix.

C. Mineral Filler

1. Portland Cement, hydrated lime, limestone dust, flyash, or other approved filler meeting the requirements of ASTM D242 shall be used if required by the Mix Design. Mineral filler shall be considered as part of the dry aggregate.

D. Water

1. Water used in the Slurry mixture shall be potable, reasonably free of oil, dirt, silt, and harmful salts.

E. Additives

1. Additives may be used to accelerate or retard the break-set of the slurry seal, or improve the resulting finished surface. The use of additives in the slurry mix or in individual materials shall be made initially in quantities predetermined by the Mix Design with field adjustments. Approval of any additive must be obtained from the Engineer prior to its use.

406.03 Laboratory Evaluation by Contractor

A. Mix Design

1. Prior to beginning work, the Contractor shall submit a Mix Design for approval by the Engineer. The Mix Design shall be the basis for the Job Mix Formula of the Slurry Seal to be used on the project. The Mix Design shall cover the materials to be used in the Slurry Seal used on the Project. The Mix Design shall be performed by a qualified laboratory who is experienced in designing Emulsified Asphalt Slurry Seal Surfacing.

The submitted Mix Design shall be signed and certified by that laboratory. Once the project Mix Design has been approved by the Engineer, no substitutions shall be permitted unless approved by the Engineer.

2. Compatibility of aggregate, emulsion, mineral filler and other additives shall be verified by the Mix Design. All component materials used in the Mix Design shall be representative of those proposed by the Contractor for use on the project.

- i. Testing

Test	Reference	Specification
Slurry Seal Consistency	ISSA T106	
Wet Cohesion – 30 min. (set)	ISSA TB-139 (quick traffic systems)	12 cg-cm min.
Wet Stripping	ISSA TB-114	pass (90% min.)
Wet Track Abrasion Loss - one hour soak		75 g/ft ² (807 g/sm)
*Mix Time	ISSA TB-113	Controllable to 180 sec. min.

* Mixing Test and Set Time Test shall be performed at the highest temperature expected during construction.

- ii. Proportioning

- a. Proportioning of the Mix Design shall be within the following limits:

RESIDUAL ASPHALT (based on the dry weight of the aggregate)	TYPE I: 10%--16% TYPE II: 7.5%--13.5% TYPE III: 6.5%--12%
MINERAL FILLER (based on the dry weight of the aggregate)	0.5%--2.0%
ADDITIVES	As needed
WATER	As needed to achieve proper mix consistency

iii. Mix Design Report – To be Submitted Prior to Construction

- a. The laboratory report of the Mix Design shall contain the following:
1. All Testing Results
 2. Quantitative effects of moisture content on the unit weight of the aggregate.
 3. Aggregate Composition and Gradation
 4. Proportions (as percentages of the total mix):
 - a) Aggregate
 - b) Mineral filler, (min. and max.)
 - c) Water, (min. and max.)
 - d) Additives, (usage)
 - e) Asphalt Emulsion
 5. Recommended Application Rate for the aggregate selected, aggregate gradation, and surface to which Slurry Seal is to be applied.

406.04 Field Tolerances

A. Tolerances for the Job Slurry Seal Mix and Individual Components shall be as follows:

Material	Tolerances
Residual Asphalt Content (as determined from Mix Design)	± one (1) % from the approved Job Mix Formula.
Aggregates	% passing each sieve within stockpile tolerances
Aggregates	% passing shall not go from the high end to low end of the specified range in any two successive sieves.
Slurry Consistency	± 0.5 cm from Job Mix Formula after field adjustments.
Application Rate	± 2#/SY while remaining within the approved design application rate.

406.05 Equipment

A. General

1. All equipment, tools, and machines used in the performance of this work shall be maintained in satisfactory working order at all times in order to insure a high quality product.

B. Mixing Equipment

1. Machines used on the project shall be specifically designed and manufactured for the mixing and application of Slurry Seal. Machines shall be self propelled, either truck mounted or continuous run design, capable of accurately delivering and proportioning the aggregate, emulsified asphalt, mineral filler, control setting additive, and water to a revolving mixer and discharge the mixed product on a continuous flow basis. The Machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive and water to maintain an adequate supply to the proportioning controls.

C. Proportioning Devices

1. Individual volume or weight controls for proportioning each material to be added to the mix shall be provided and properly marked. Proportioning devices shall be equipped with revolutionary counters or similar device for each material to be added to the mix so material output can be determined at any time.
2. The Contractor shall allow the Engineer access to the recorders and measuring devices of the Slurry Seal machine to determine application rates of all materials for a single load.

D. Spreading Equipment

1. Spreading equipment shall be capable of uniformly spreading the Slurry Seal mixture. This shall be accomplished by means of a conventional surfacing spreader box attached to the mixer equipped to agitate and spread the mixture evenly throughout the box. A front seal shall be provided to insure no loss of the mixture at the road contact point. The rear seal shall act as a final strike-off and shall be adjustable. The spreader box and rear strike-off shall be designed and operated in a manner that will insure that a uniform consistency is achieved to produce a free flow of material to the rear strike-off. The spreader box shall be capable of shifting to the side in order to compensate for variations in the pavement surface geometry.

2. The spreader box shall be kept clean and free of asphalt and aggregate build up. Approved drag or screed attached to the rear of the spreader box may be required by the Engineer in order to produce a uniform, textured mat. If a drag or screed is used, it shall be kept clean or replaced as necessary to insure that slurry mix accumulations do not cause scores or streaks in the new mat.

E. Auxiliary Equipment

1. Suitable surface preparation equipment, traffic control equipment, hand tools, and any other support equipment shall be provided as necessary to perform the work.

406.06 Calibration

- A. Each mixing unit used in performance of the work shall be calibrated in the presence of the Engineer or his representative. Previous calibration documentation covering the exact materials to be used on the project may be accepted, provided they were made during the same calendar year. Documentation shall include an individual calibration of each material at various settings, which can be related to the metering devices on the machine. No machine shall be used on the project until calibration has been completed and accepted.

1. Verification

- i. At minimum, five (5) days prior to construction and after calibration, each machine to be used on the project shall install a test strip. All test strips shall be within the project area. At the time test strips are being applied, samples of the slurry seal shall be taken by an independent laboratory selected by Contractor and approved by Owner and Engineer in order to verify mix consistency and proportioning. The costs of the laboratory testing are to be borne by the Contractor. The rate of application shall also be verified. In the event the test strip is not in compliance with project requirements due to the failure of any test, the Contractor shall make corrections and place another test strip at no additional cost to the Owner. Any unit failing to meet project requirements after three (3) trials shall not be permitted to operate on the project. Construction shall not commence until an acceptable test strip is placed. The Owner reserves the right to obtain an outside testing firm to verify any and all testing results. Any outside testing shall be paid for by the Owner.

406.07 Weather Limitations

Both pavement and air temperature shall be 45° F (7°C) and rising prior to the application of Slurry Seal. Slurry Seal shall not be applied when there is a danger of freezing within 24 hours of application. Slurry Seal shall not be applied when weather conditions prolong opening traffic beyond a reasonable time (2-3 hours). The Contractor shall use his judgement when rain, freezing or any

inclement weather is forecast. Any slurry seal damaged by inclement weather shall be repaired by the Contractor at his expense.

406.08 Surface Preparation

A. General

1. Immediately prior to the application of Slurry Seal, the Contractor shall clean the surface of all loose material, oil spots, vegetation, and any other objectionable material. Any standard cleaning method that thoroughly cleans the surface will be acceptable. If water is used, cracks shall be allowed to dry thoroughly before the application of slurry seal. Dust produced by cleaning operations shall be controlled by sprinkling the surface with water as directed by the Engineer.
2. All manhole lids, catch basin grates, water and gas valve lids, survey monuments, and any other such street appurtenance shall be protected prior to the application of slurry seal. Protection shall allow the slurry seal application without adverse effect to the final finish.

B. Tack Coat

1. Should Tack Coat be required due to surface condition, the surface to be slurry sealed shall be treated with tack coat. Tack coat shall be proportioned at one (1) part emulsified asphalt and three (3) parts water. The emulsified asphalt used shall be the same used in the slurry seal mix. Tack coat shall be applied evenly at a rate of .05 to .10 gallons per square yard (0.15 to 0.35 liters per square meter). Tack coat shall be allowed to cure before application of the slurry seal.
2. Application of Tack Coat shall be applied only at the direction of the Engineer and shall be paid for as a separate item.

406.09 Application

A. General

1. The surface to be slurry sealed shall be prewetted by fogging ahead of the spreader box. The rate of application of the fog spray shall be adjusted periodically to suit temperatures, surface texture, humidity, and dryness of the pavement.
2. The slurry seal mixture shall be the desired consistency upon leaving the mixer. A sufficient amount of material shall be carried in all parts of the spreader at all times to attain complete coverage. Overloading of the spreader shall be avoided.

3. Lumping, balling, or unmixed aggregate shall not be permitted.
4. Streaks left in the finished surface shall not be permitted. If excess oversize develops, construction shall be halted and the situation corrected by the Contractor. Work shall not resume until the Contractor satisfies the Engineer that corrections have been made. The Contractor shall screen the aggregate prior to using in the lay down operation as directed by the Engineer.

B. Joints

1. The Contractor shall provide a spreading machine of suitable width to produce a minimum number of longitudinal joints in the project area. Joints showing excess buildup, uncovered areas, or unsightly appearance shall not be acceptable. Whenever possible, longitudinal joints shall be placed on lane lines. Odd width passes and half passes shall be kept to a minimum. Overlap of longitudinal joints shall not exceed six inches (6") (150mm).

C. Mix Stability

1. Slurry Seal shall possess sufficient stability so that premature breaking of the material in the spreader box does not occur. The mixture shall be homogeneous during and following mixing and spreading. It shall be free of excess water and emulsion and free of segregation of the emulsion and aggregate fines from coarser aggregate. Spraying additional water into the spreader box shall not be permitted.

D. Hand Work

1. Areas that cannot be surfaced with the slurry seal machine shall be surfaced manually using hand squeegees to provide uniform coverage. Areas requiring handwork shall be lightly dampened prior to the application of slurry seal mix and the mix worked immediately. The Contractor shall take care not to leave unsightly handwork. Surfaces done by hand shall have the same finish as those applied by the spreader box. All handwork shall be accomplished at the same time as the machine application.

E. Lines

1. The Contractor shall insure straight lines along curbs and shoulders. Runoff in these areas shall not be acceptable. Lines at intersection shall be kept straight to provide good appearance.

F. Clean-up

1. All areas, such as concrete flatwork, manhole covers, water and gas valve covers, and any surface where slurry seal should not be applied, shall be removed as directed by the Engineer. The Contractor clean up the project site and remove any debris associated with the project daily.

406.10 Quality Control

A. Testing

1. The Contractor shall select and pay for a certified testing firm, acceptable to the Owner and Engineer, to complete all sampling and testing as outlined. This firm may be the firm who performs the Mix Design. Payment for this work shall be included in the unit price for Slurry Seal.
2. The Contractor shall plan an adequate number of qualified persons and equipment to perform all required tests and sampling to meet the Contractor's schedule and within the time frame required in these specifications.
3. Testing will be performed, as a minimum, according to the following schedule:
 - i. The Contractor shall take samples of the aggregate and asphalt emulsion and perform the required testing at intervals specified.
 - ii. Samples of Slurry Seal shall be taken directly from the Slurry Unit at a minimum rate of one sample per mixing unit per day. Consistency and residual asphalt content test shall be made on the samples and compared to the specifications.
 - iii. The Contractor shall be responsible for checking stockpile moisture content in order to adjust machine settings accordingly to account for aggregate bulking.
4. Test results shall be compared to specifications and reported to the Engineer through the Contractor. The Contractor shall notify the Engineer of any failing tests.
5. The Engineer shall be allowed to use the recorders and measuring facilities of the slurry seal unit at any time to determine application rates, asphalt emulsion content, mineral filler, and additive content for any individual load.
6. The Contractor shall submit samples of the asphalt emulsion and aggregate being used on the project to the Engineer as requested during construction. At least one (1) sample of each shall be submitted prior to construction.

B. Non-Compliance

1. In the case of two consecutive failing tests on the stockpiled materials, construction shall cease immediately. It is the responsibility of the Contractor to provide proof to the Engineer that all out of compliance conditions have been corrected prior to recommencement of construction.
2. If any two successive tests on the mix from the same machine are out of compliance, the use of that machine shall be suspended until the Contractor provides proof to the Engineer that the situation has been corrected and the machine is functioning properly.

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406.11 Appendix

AGENCIES AND TEST METHODS

I. AGENCIES

AASHTO.....American Association of State Highway and Transportation Officials
 ASTM.....American Society for Testing and Materials
 ISSA.....International Slurry Surfacing Association

II. TEST METHODS

A. AGGREGATE AND MINERAL FILLER

Test		Short Title
AASHTO T2	ASTM D75	Sampling Mineral Aggregates
AASHTO T27	ASTM C136	Sieve Analysis of Aggregates
AASHTO T11	ASTM C117	Material Finer than No.200 in Mineral Aggregate
AASHTO 176	ASTM D2419	Sand Equivalent Value of Soils and Fine Aggregate
AASHTO T84	ASTM C128	Specific Gravity and Absorption of Fine Aggregates
AASHTO T19	ASTM C29	Unit Weight of Aggregates
AASHTO T96	ASTM C131	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine (performed on parent rock)
AASHTO T37	ASTM D546	Sieve Analysis of Mineral Filler
AASHTO T104	ASTM C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
	ASTM D242	Mineral Filler for Bituminous Paving Mixtures
AASHTO T127	ASTM C183	Sampling Hydraulic Cement

B. EMULSIFIED ASPHALT

Test		Short Title
AASHTO T40	ASTM D140	Sampling Bituminous Materials
AASHTO T159	ASTM D244	Testing Emulsified Asphalt
AASHTO M140	ASTM D977	Specification for Emulsified Asphalt
AASHTO M208	ASTM D2397	Specification for Cationic Emulsified Asphalt
	ISSA T102	Mixing, Setting and Water Resistance Test to Identify "Quick-Set" Emulsified Asphalt

C. RESIDUE FROM EMULSION

Test		Short Title
AASHTO T-59	ASTM D244	Residue by Evaporation
AASHTO T49	ASTM D2397	Penetration 100gm at 5 sec. 77 F (25 C)

D. SLURRY SEAL SYSTEM

Test	Short Title
ISSA T101	Guide for Sampling Slurry Mix for Extraction
ISSA T106	Measurement of Slurry Seal Consistency
ISSA T109	Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester
ISSA T111	Outline Guide Procedure for Slurry Seal
ISSA T112	Method of Estimate Slurry Seal Spread Rates and to Measure Pavement Macro texture

Test	Short Title
ISSA T114	Wet Stripping Test for Cured Slurry Seal Mixes
ISSA T115	Determination of Slurry Seal Compatibility
ISSA T139	Method of Classified Emulsified Asphalt, Aggregate Mixtures by Modified Cohesion Test Measurement of Set and Cure Characteristics
ASTM D3910	Design, Testing and Construction of Slurry Seal
ASTM D2172	Quantitative Extraction of Bitumen for Bituminous Paving Mixtures

DIVISION 400

SECTION 407

**BITUMINOUS MIXTURE
THIN-WEARING SURFACE
(CARPET COAT)**

407.01 Description.

The work specified in this Section shall consist of placing a carpet coat over an existing asphaltic concrete pavement, in reasonably close conformity with the lines, grades, thickness, and typical cross-sections shown on the plans or established by the Engineer.

407.02 Materials.

A. Gradation of Aggregate

<u>Sieve Size</u>	<u>% Passing By Weight</u>
3/8" (9.5mm)	100
#4 (4.75mm)	62.5-70
#10(2mm)	32-50
#40 (425 μ m)	21-27
#50 (330 μ m)	16-22
#100 (150 μ m)	9-15
#200 (75 μ m)	5-8

B. Asphalt Content.

1. Asphaltic cement shall be PGM58.22. The grade of asphalt cement shall meet the requirements for grade and type as specified in AASHTO Standard Specifications for viscosity graded asphalt cement M226, Table I, current Edition. The type and grade of bituminous material may be changed one step by the Engineer during construction, at no change in unit price.

C. General Requirements.

1. Uniformity. The plant shall be so designed and operated as to produce a job mixture whose permissible variance from the mix design shall be as follows:

Amount passing on the No. 4 sieve and larger	+ 5%
Amount passing on the No. 8 to No. 110 sieves	+ 5%

Amount passing on the No. 40 sieve	+ 5%
Amount passing on the No. 200 sieve	+ 3%
Bitumen	±.5%

i. The mixture shall have a density, when thoroughly compressed, of not less than 97% of field sampled laboratory Marshall density.

2. Paving Plant Inspection. For verification of weights or proportions and character of materials, and determination of temperatures used in the preparation of mixture, the Engineer, or his authorized representatives, shall have access at any time to all parts of the paving plant.

D. Bituminous Mixture Design Criteria. The following Marshall Design Criteria shall be used to determine optimum asphalt content:

No. of Compaction Blows Each End of Specimen - 50.

Test Property	<u>Min.</u>	<u>Max.</u>
Stability, all mixtures (lbs.) (kg)	1200(550kg)	---
Flow, all mixtures (in.)(mm)	.08(2mm)	.16 (4.5mm)

407.03 Execution.

A. General Conditions.

1. Weather Limitations. Bituminous plant mix shall not be placed on any wet surface or when the atmospheric temperatures are less than those specified in the following table; or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

<u>Atmospheric Temperature Limitations</u>	
<u>Compacted Thickness</u>	<u>Carpet Coat</u>
Less than 1" (25mm)	70° F(21 ⁰ C)

B. Transportation of Mixture. The mixture shall be transported from the paving plant to the work in vehicles equipped with tight metal compartments previously cleaned of all foreign materials. When directed by the Engineer, the compartments shall be suitably insulated and each load shall be covered with canvas or other suitable materials of sufficient size to protect it from weather conditions. The inside surface must be lightly lubricated with a thin oil just before loading, but excessive lubricant will not be permitted. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight.

- C. Placing Asphalt Mixture. The mixture shall be delivered on the work site at a temperature $\pm 15^{\circ}$ F. (-9° C) of the mixing temperature, but in no case shall the temperature be below 240° F. (115° C). Final rolling and density of the bituminous surface, subsurface, or leveling courses must be obtained prior to the mixture reaching a minimum temperature of 180° F. (82° C).
1. Unless otherwise permitted by the Engineer, the mixture shall be spread by means of a mechanical self-powered paver, capable of spreading the mixture true to the line, grade, and crown shown on plans. Hand-placing and spreading will be permitted in irregular areas where it is impractical to use a paving machine.
 2. Pavers shall be equipped with hoppers and distributing screws of the reversing type to place the mixture evenly in front of adjustable screeds. The mixture shall be dumped in the center of the hoppers and care exercised to avoid overloading and spilling over the mixer upon the base. Pavers shall operate, when laying mixtures, at such speed between ten feet (10') (3m) and twenty feet (20') (6m) per minute as may be decided by the Engineer.
 3. Pavers shall be equipped with a quick and efficient steering device and shall have forward and reverse traveling speeds of not less than one hundred feet (100') (30m) per minute and a tamping device capable of delivering at least 500 blows per minute.
 4. Unless operating on fixed side forms, pavers shall employ mechanical devices such as equalizing runners, straight-edge runners, evener arms, or other compensating devices to adjust the grade and confine the edges of the mixtures to true lines without the use of stationary side forms. The pavers shall be capable of spreading the mixtures, without segregation, in thickness of from one-half inch (1/2") (12.5mm) to three inches (3") (75mm) and in widths of eight feet (8') (2.5m) to fourteen feet (14') (4.5m) adjustable in steps of one foot (1') (.3m) or less. They shall be equipped with blending or joint leveling devices for smoothing and adjusting all longitudinal joints between adjacent strips of courses of the same thickness.
 5. Pavers shall be equipped to automatically control the laying of the mixture to specified transverse slope and established longitudinal grade. The paver control system shall be automatically actuated from an independent line and grade control reference through a system of mechanical sensors and sensor-directed devices which shall maintain the paver screed at the proper transverse slope and height to establish the top surface of the compacted mixture at specified slope and grade.
 6. The term "screed" includes a "strike-off" device operated by cutting, crawling, or other practical action which is effective on the mixture at a workable temperature without tearing, shoving, or gouging, and which produces a finished surface of the evenness and texture specified. The screed shall be adjustable as to level and shall have an indicating level attached.

7. Immediately after any course is screeded, and before roller compaction is started, the surface shall be checked, any inequalities adjusted, and replaced with satisfactory material. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is rolled.
 8. The Contractor shall provide a competent worker who is capable of performing the work incidental to the correction of all pavement irregularities. Special attention shall be given by the worker to the straight-edging of each course immediately following the initial rolling.
 9. In narrow, deep, or irregular sections, intersections, turnouts, or driveways where it is impractical to spread and finish the mixtures by machine methods, the Contractor may use approved spreading equipment or acceptable hand methods as directed by the Engineer.
 10. When the mixture is to be spread by hand, upon arrival on the work it shall be dumped upon a steel dump board outside the area on which it is to be spread, or shoveled directly from the truck to the area on which it is to be spread. Immediately thereafter it shall be distributed into place by means of hot shovels and spread with hot rakes in a loose layer of uniform density and correct depth. Tines of the rakes shall be not less than one-half inch (1/2") (12.5mm) longer than the loose depth of mixture, and spaces between tines shall be not less than the maximum diameter of aggregate particle except that in no case should the spaces be less than one inch (1") (25mm). Loads shall not be dumped any faster than they can be properly handled by the shovelers. Lutes may be used with permission of the Engineer.
 11. The shoveler shall not distribute the dumped load faster than it can be properly handled by the rakers.
 12. The rakers will not be permitted to stand in the hot mixture while raking it, except where necessary to correct errors in the first raking. The raking must be carefully and skillfully done in such a manner that after the first passage of the roller over the raked mixture, a minimum amount of back patching will be required.
 13. The placing of the mixture shall be as continuous as possible. The roller shall pass over the unprotected edge of the freshly laid mixture only when the laying of this course is to be discontinued for such intervals of time as to permit the mixture to become chilled.
- D. Joints. Transverse construction joints shall be made in a careful manner. The edge of the previously laid course shall be cut back as far as is necessary to eliminate irregularities incidental to finishing and rolling. After laying the finished mixture adjacent to a transverse construction joint, a skilled laborer shall follow up each rolling with a straight-edge and corrective measures to insure a smooth riding surface. The laborer shall be equipped with hot smoothing irons, tampers, and other devices for use in truing up the pavement surface adjacent to the joint.

1. Longitudinal joints against both hot and cold material shall be made with equal care. Mixtures spread and compacted (or partially compacted) by the machine shall not be disturbed by a rake in dressing the joint, unless one side is too high, nor shall surplus mixture be spread or scattered back of the machine when not needed to build up low spots. When spreading next to a warm or cold edge of a previously laid section of surfacing, the machine shall be adjusted to leave a "bead" of material, roughly one inch (1") (25mm) by one inch (1") (25mm), which shall be rolled in to compensate for uneven density at the joint. If one side of the joint is cold, the "bead" shall be moved back of the rake to the warm side of the joint but otherwise the machine-laid mixture shall not be disturbed.
 2. In making the joint along any adjoining edge such as curb, gutter, or an adjoining pavement, and after the hot mixture is placed by the finishing machine, just enough of the hot material shall be carried back to fill any space left open, and provide a small "bead" of extra material. This joint shall be properly "set-up" with the back of the rake at proper height and bevel to receive the maximum compression under rolling. The work of "setting-up" this joint shall always be performed by competent workers, who are capable of making a correct, clean, and neat joint.
- E. Compaction of the Mixture. As soon as the mixture will carry the compaction equipment without undue shoving or displacement, it shall be compacted with self-propelled rollers meeting the following criteria:
1. Three-axle tandems, two-axle tandems, and three-wheeled rollers used for breakdown rolling shall be of such weight that the compression load on the drive wheels is at least three hundred twenty five pounds per inch (325lb/in) (58kg/cm) of tire width.
 2. Vibratory rollers used for breakdown or intermediate rolling having a compactive effort of not less than a dynamic force of twenty one thousand pounds (21,000#) (9525kg) may be used only with the written consent of the City Engineer, and should not be used on lifts of two inches (2") (50mm) or less.
 3. Two-axle tandem rollers used for intermediate and finish rolling shall weigh not less than seven tons (7t) (6.3 metric t).
 4. Pneumatic-tired rollers used for intermediate rolling shall be the oscillating type having a width of not less than four feet (4') (1.2m) and equipped with pneumatic tires of equal size and diameter, having treads satisfactory to the Engineer. Wobble-wheel rollers will not be permitted. The tires shall be so spaced that the gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to ninety pounds per square inch (90psi) (621 kPa) or such lower pressure as designated by the Engineer, and maintained so that the air pressure will not vary more than five pounds per square inch (5psi) (35 kPa) from the designated pressure. Pneumatic-tired rollers shall be so constructed that the total weight of the roller can be varied to produce an operating

weight per tire of not less than two thousand pounds (2,000#) (907kg). The total operating weight of the roller shall be varied as directed by the Engineer.

- i. Other rollers may be used subject to prior approval by the Engineer.
5. All rollers must be maintained in good mechanical condition, and those that cannot be driven along a straight path or operated without jerking, shall not be used. No leakage of petroleum products from any roller shall be allowed to come in contact with pavement being constructed, nor shall any roller be permitted to stand motionless on any portion of the work. The surfaces of all roller wheels shall be treated with sufficient water to prevent the pickup of bituminous materials, but under no circumstances shall the quantity of water used be detrimental to the surface of the pavement being rolled.
6. As soon as the layer of asphalt concrete has been placed, it shall be thoroughly compacted by rolling. Except when compacting lifts greater than four inches (4") (100mm) in compacted thickness, rolling shall be commenced along the lower edge of the area to be rolled and continued until the edge is thoroughly compacted, after which the roller shall be gradually advanced to the crown point, both sides being rolled in like manner. Rolling shall be continued until the pavement layer has become thoroughly compacted throughout and is true to grade and cross-section.
7. For lifts greater than four inches (4") (100mm) in compacted thickness, rolling shall be commenced in the middle of the mat, after which the roller shall be gradually advanced to both edges. The roller should be advanced to a supported edge first, if applicable. Rolling of an unsupported edge should be delayed as long as possible, provided the required densities are obtained after the completion of the finishing rolling.
8. The finish rolling of the surface course shall be done with a tandem steel-wheeled roller until all roller marks are eliminated.
9. Along curbs, headers, manholes, and similar structures, and at all places not accessible to the roller, thorough compaction must be secured by means of hot tampers and irons. At all contacts of this character, the joints between these structures and the surface mixture must be effectively sealed.
10. After final compression, the surface course shall conform with the following requirements:
 - i. It shall be smooth and true to the established crown and grade. It shall have the average thickness specified and shall at no point vary more than one-fourth inch (1/4") (6.25mm) from the thickness shown on the typical cross-sections on the plans. Any low or defective places shall immediately be remedied by cutting out the course at such spots and replacing it with fresh, hot mixture which shall be immediately compacted to conform with the surrounding areas and shall be thoroughly bonded to it. The surface of the finished pavement shall be free from depressions exceeding

one-fourth inch (1/4") (6.25mm) as measured with a ten foot (10') (3m) straight edge in any direction.

407.04 Quality Control.

- A. All testing and sampling shall be done in accordance with the latest A.A.S.H.T.O. Methods unless otherwise specified. The following tests shall be required during construction.
1. Asphalt Content and Gradation. One asphalt content and gradation test shall be made per each four hundred tons (400t) (360 metric t) or portion thereof of asphaltic mixture placed per day. These tests shall be performed on samples taken prior to screeding. The percentage of asphalt content may be determined by extraction or ignition oven. (ASTM D 2172, D 6307, ASHTO T164).
 2. Marshall Series. A complete Marshall test series shall be performed each week of paving operations.
 3. Preconstruction Test and Sampling. All sampling and testing of materials shall be in accordance with the latest A.A.S.H.T.O. Methods unless otherwise specified. At least three (3) weeks in advance of the beginning of asphaltic paving work, the Contractor shall:
 - i. Submit suitable samples of all materials including asphalt cement to an approved materials testing laboratory for mixture design, and to determine compliance of materials to these specifications;
 - ii. Or shall submit certification that the materials to be used are in conformance with these specifications and that the mixture design for use with these materials is approved and on file with the City Engineer.
 4. The Contractor shall be responsible for all preconstruction tests and sampling, Marshall series testing, and all asphalt content and gradation testing. The Contractor shall select and pay for a certified testing firm, acceptable to the Owner and Engineer.
 5. Unless specified by the contract documents or Standard Specifications, the Owner/Engineer will be responsible for all density/moisture testing. If the initial test fails to meet minimum requirements, the Contractor shall pay for any and all additional tests until the minimum density/moisture standards are met.

407.05 Cleaning.

The Contractor will be required to perform all preparatory operations of cleaning the surface of the existing pavement that are necessary for the workmanlike construction of the asphaltic concrete

resurfacing course. The pavement shall be cleaned of all dirt, "fat" spots of armor coat, loose armorcoat, and bituminous patches containing an excess of asphalt.

407.06 Reconstructed Areas

Wherever within the locations of this work any evidence of heaving or spalling shall occur so as to greatly effect the line and cross section of the completed resurfacing, such areas shall be removed and replaced upon written orders of the Engineer. Compensation for such work shall be paid for as outlined in the Special Provisions. Such bad spots shall not be construed to mean crack filling or general cleaning operations already covered by these specifications.

407.07 Patching.

Any area designated by the Engineer to be "patched" before the placing of a hot mix asphalt mat, shall be completed in the following manner: All asphalt and/or P.C.C. shall be removed, hauled away, cut, and chipped to true lines with vertical faces and completely cleaned of all debris. The Contractor shall provide and employ such equipment and methods of compaction as are necessary to obtain the specified density in narrow or irregular areas.

407.08 Adjustment.

- A. Adjustment of Manholes and Water Valve Boxes. Manhole covers and water valve boxes shall be adjusted so that the tops are parallel to the street grade and cross-slope. The tops shall be set one-fourth inch (1/4")(6.25mm) below the finished pavement surface.
 1. Adjustment of boxes and manholes shall take place prior to placement of carpet coat. Sanitary and storm sewer manhole frames and valve boxes may be adjusted by using manufactured adjusting rings, only if the top of the adjusting ring in place matches the final pavement surface as described above.

DIVISION 500

SECTION 501

WATER DISTRIBUTION AND TRANSMISSION SYSTEMS

501.01 Description

- A. This Section covers the furnishing and installation of all materials, labor, tools, and equipment to construct complete, in-place water mains and all appurtenances in accordance with the requirements of the Contract Documents, and as specified herein. The Contractor shall also do the excavating of all kinds of materials encountered, furnish or compact foundations where required, furnish and install all timbering, sheeting and bracing necessary or proper to safely support all work, remove all water, protect, repair, relocate, maintain, and restore all subsurface, surface, and overhead structures directly or indirectly disturbed, injured, or affected by his operations, and furnish all other appurtenant items and services necessary or specified.

501.02 References, Specifications, Codes, and Standards

- A. References:

AWWA C104	Standard for Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water
AWWA C105	ANSI Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Standard for Ductile Iron and Gray Iron Fittings, 3” through 48” (75mm through 1.2m), for Water
AWWA C111	Standard for Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings
AWWA C116	Protective fusion-bonded coatings for the interior and exterior surfaces of ductile-iron and gray-iron fittings for water supply service
AWWA C151	Standard for Ductile Iron Pipe, Centrifugally Cast, for Water
AWWA C153	Ductile-iron compact fittings for water service
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

AWWA C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings For The Exterior of Special Sections, Connections, and Fittings For Steel Water Pipelines
AWWA C500	Metal Seated Gate Valves for Water Supply Service
AWWA C502	Dry Barrel Fire Hydrants
AWWA C504	Rubber Seated Butterfly Valves
AWWA C509	Resilient Seated Gate Valves for Water Supply Service
AWWA C512	Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
AWWA C515	Reduced-wall resilient-seated gate valves for water supply service
AWWA C550	Protective Epoxy Interior Coatings For Valves and Hydrants
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 in. through 12 in. (100mm through 300mm), for Water Distribution
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. (350mm through 1,200mm) for Water Transmission and Distribution
AWWA C907	Polyvinyl Chloride (PVC) Pressure Fittings for Water-4 in. through 8 in. (100mm through 200mm)
AWWA C909	Molecularly Oriented Polyvinyl Chloride (PCVO) Pressure Pipe, 4 in. through 12 in. (100mm through 300mm), for Water Distribution

501.03 Submittals

- A. The Contractor shall submit manufacturers' specification data and manufacturers' installation instructions, in accordance with the Contract Documents, for all materials proposed for use on the project. Contractor shall submit information a minimum of ten (10) working days prior to the scheduled start of construction to allow adequate time for review and approval. A minimum of five (5) copies of all information shall be submitted. The Engineer shall approve the list of materials prior to the Contractor commencing installation operations.

501.04 Materials

- A. The materials used in this work shall all be new and conform to the requirements for class, kind, size, and material as specified herein.
 - 1. A copy of the manufacturer's installation recommendations for each kind of pipe used must be provided to each foreman and inspector prior to construction and must be followed during construction unless otherwise instructed.
 - 2. When required by the Engineer, the Contractor shall furnish certification by the manufacturer of the pipe to be furnished on this project, certifying that the pipe and fittings comply with the applicable specifications.
 - 3. All pipe shall be clearly marked with type, class and/or thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.
 - 4. Except in locations where the soils are contaminated by hydrocarbons and other locations designated by the City, all water main piping shall be polyvinyl chloride pipe (PVC) AWWA C900 or C909 (4" through 12") (100mm – 300mm) and C905 (14" through 36") (350mm – 900mm). In addition, all eight-inch and smaller waterline fittings may be PVC conforming to AWWA C907. Sleeves used for joining four to eight inches (4" – 8") (100mm – 200 mm) pipe shall be push-on PVC sleeves conforming to AWWA C907 except when joining oversized existing pipe. MJ gray iron or ductile iron bored solid sleeves long pattern shall be used for connection to oversized existing piping. Sleeves joining twelve to forty-two inch (12" – 42") (300mm – 1050mm) pipe shall be MJ ductile iron or gray iron solid sleeve long pattern.
 - 5. Water main pipe installed in soils contaminated with hydrocarbons shall be ductile iron with "buna-n-nitrile" gaskets and double polywrapped. Water main fittings, fire hydrants, and valves, etc., installed in soils contaminated with hydrocarbons shall be ductile or cast iron, with "buna-n-nitrile" gaskets, and double polywrapped. City may require "viton" gaskets in severe soil contamination conditions.

6. All metallic pipe, fittings and appurtenances shall be bonded and protected from corrosion by coatings, sacrificial anodes and/or other means appropriate to the location and approved by the Engineer. (See Division 500 Section 503 of these specifications)
7. Tracer/locator wire shall be taped to the bottom of all buried pvc water mains and fire hydrant leads for future pipe locating purposes. Blue tracer/locator wire insulated with high molecular weight polyethylene (HWWPE) specifically designed for use in direct burial applications shall be used. The wire shall be solid copper wire 10 AGW, UL listed, and suitable for 600 volts. All splices for tracer/locator wire shall be spliced using 3m dby/dbr direct bury splice kits suitable for 30 volts or equivalent. The tracer/locator wires will end in tracer/locator boxes alongside each fire hydrant. The tracer/locator boxes shall be plastic boxes with a minimum of two terminal blocks secured in place below a locking heavy cast-iron cover. C.P. mini box 2.5 inch or Handlay 2 3/8 inch cathodic test station box or equivalent shall be used. Cathodic protection test stations (Section 503.03.1) shall not be used for tracer/locator boxes.

B. Ductile Iron Pipe and Fittings

1. Ductile iron pipe shall conform to the requirements of AWWA C501, laying condition Type 5, except the minimum design thickness shall be Class 350. Ductile iron pipe shall be four inch (4") (100mm) or larger. No three-inch (3") (76mm) pipe shall be allowed.
2. Mechanical joint pipe or "push on" joint pipe shall comply with AWWA C111.
3. All pipe joints shall be an approved slip type or mechanical joint with rubber gasket. Gaskets shall be molded nitrile rings or other approved material made expressly for the joint used and resistant to deterioration from contact with the soils where installed.
4. The interior of the pipe shall have a cement mortar lining conforming to the requirements of AWWA C104. The pipe exterior shall be a tar or bituminous seal coating at least one mil thick. The coating shall adhere to the pipe and spotty or thin coating, or poor adhesion, shall be cause for rejection of the pipe.
5. When so directed by the Engineer, the Contractor shall provide accurate scales near the site of the construction. He shall weigh a sufficient number of pipes and fittings from each shipment to verify the weight. Should the weight prove inconsistent, the Engineer may require the weighing of all materials delivered. The cost of all weighing shall be at the Contractor's expense.
6. Fittings may be either gray iron or ductile iron, and shall be Class 250 conforming to AWWA C110 covering standard fittings or Class 350 conforming to AWWA C153 covering compact fittings. Either mechanical joints or push-on joints

meeting AWWA C110, or AWWA C153, may be used.

7. Couplings for making connections to existing pipelines shall be mechanical joint solid sleeves (long) or approved equal. Special fittings shall be in accordance with the plans.
8. All mechanical joint bolts, nuts, and washers shall be Type 304 stainless steel. Bolts shall be tee-headed. Nuts may be one and one-quarter inch or one and one-eighth inch (1¼" or 1-1/8") (31.25mm or 28mm). Stainless steel washers shall be provided for all MJ bolts. The washers shall have an outside diameter of one and one-half inch (1½") (37.5mm) and an inside diameter able to accommodate the stainless steel bolt. A suitable lubricant shall be used during assembly of stainless steel nuts and bolts.
9. All metallic pipe, fittings and appurtenances shall be bonded and protected from corrosion by coatings, sacrificial anodes and/or other means appropriate to the location and approved by the Engineer. (See Division 500 Section 503 of these specifications.)
10. The interior of fittings shall have a cement mortar lining conforming to the requirements of AWWA C104 or fusion bonded epoxy coating conforming to the requirements of AWWA C116.

C. Polyvinyl Chloride Pipe and Fittings

1. PVC pipe is to have an outside diameter identical to that for ductile iron pipe. Pipe joints shall be approved slip type joints with an elastomeric gasket. All PVC pipe shall be "NSF" (National Sanitation Foundation) approved for use in potable water systems.
2. Sizes four-inch (4") (100mm) through twelve-inch (12") (300mm) pipe and fittings shall conform to AWWA C900 or AWWA C909. Pressure Class 150 shall be used for working pressures less than 125 psi (863 kpa). Pressure Class 200 shall be used for working pressures of 125 psi (863 kpa) and above. PVC fittings four inch (4") (100mm) through eight inch (8") (200mm) shall conform to AWWA C907.
3. Sizes fourteen-inch (14") (350mm) through forty-eight inch (48") (1.2m) pipe and fittings shall conform to AWWA C905. DR 25 shall be used for working pressure up to 100 psi (690 kpa). DR 18 pipe shall be used for working pressures between 100 psi (690 kpa) and 125 psi (863 kpa), and DR 14 pipe shall be used for working pressures of 125 psi (863 kpa) and above.
4. Fittings for PVC pipe shall be PVC conforming to AWWA C900, C905, or C907 as applicable, whenever possible. Gray iron or ductile iron fittings meeting the requirements of Division 500 Section 501.04 B. above may be used when necessary.

D. Valves and Boxes

1. All valves twelve inches (12") (300mm) and smaller shall be resilient-seated gate valves. All valves over twelve inches (12") (300mm) shall be butterfly valves unless otherwise specified in the Contract Documents.
2. All gate valves shall have an iron body, with a bronze mounted non-rising stem; and with "O" ring seals designed for 200 psi (1400kPa) working pressure. They shall have mechanical or push-on joints.
3. The resilient seat shall have openings through the body of the same circular area as that of the pipe to which they are attached. Gate valves shall open counterclockwise and shall have a two-inch (2") (50mm) square wrench nut for key operation.
4. Resilient-seated gate valves shall be designed for 200 psi (1400kPa) working pressure with mechanical or push-on joints. They shall conform to AWWA C509, or AWWA C515. The valves shall open counterclockwise and have a two-inch (2") (50mm) square nut for key operation.
5. Resilient-seated gate valves with push-on joints may be used for PVC and ductile iron pipe only if specifically designed for that purpose.
6. Butterfly valves for use in the water distribution system shall be Class 150B rubber seated, tight closing butterfly valves conforming to AWWA C504 with adjustable stops. Butterfly valves shall be furnished with mechanical joint ends or push-on type and have lubricated screw type operators designed for underground service.
7. Rubber valve seats shall be replaceable without disassembling the valve and shall not be interrupted by the shafting. Rubber seats may be retained on the disc edge by stainless steel clamping in lieu of bonding to the valve body. Shaft packing shall be of the self-adjusting permanent type or O-ring.
8. Operators for underground service shall be permanently lubricated screw-type operators, totally enclosed and of watertight construction. Overload protection shall be incorporated into the operator allowing the application of 450 foot-pounds (600N-M) input torque at full-open and full-closed positions without damage to the operator or valve. A two-inch (2") (50mm) square wrench nut and valve box shall be provided for operating the valve. No roll pins will be allowed on the operating nut. Valves shall open counterclockwise.
9. Certification of performance conforming to AWWA C504, Rubber Seated Butterfly Valves, and meet the requirements for Class 250 shall be furnished to the Engineer. Valves to have bi-directional shutoff and they shall be factory tested in both directions.

10. Mechanical joint gland and exterior and interior coating requirements for all valves shall be the same as Division 500 Section 501.04.B.9 above. The valve body shall be furnished with stainless steel bolts.
11. Valve boxes shall be cast iron, 5 1/4" (130mm) diameter adjustable valve boxes. Valve boxes shall be of the screw type and of sufficient length for the pipe bury as specified. The cast iron cover of the valve box shall have the word "Water" stamped thereon. They shall be Tyler 6850 Series S or approved equal. An approved valve box adapter shall be used to keep the valve box centered over the valve.
12. All air valves shall be a combination air release/vacuum relief valve two inch (2") (50mm), conforming to AWWA C512, as manufactured by Clow (Model No. 5403-B 200 psi), Apco (Model No. 145C heavy duty), or approved equal. The air release/vacuum relief valve shall be placed in a manhole and flat slab cover meeting ASTM C-478. (See Drawing A5 for details)

E. Pressure Taps (Four-inch (4") (100mm) and larger)

1. All pressure taps shall use stainless steel tapping sleeves. The sleeve, outlet, flange and bolts shall be constructed of grade 18-8 type 304 stainless steel. The outlet shall be schedule 10 for four-inch (4") (100mm) outlet and schedule 5 for outlets larger than four inch (4") (100mm). The taps shall use full circle compounded gaskets for water service, complying with ASTM D2000-80M. The entire sleeve shall have a 150 psi working pressure rating. Sizing shall range from four-inch (4") (100mm) through twenty-four-inch (24") (600mm) with flange outlets from four-inch (4") (100mm) through twelve-inch (12") (300mm) Ford style FAST, Romac SST, JCM 432, or approved equal.
2. All auxiliary valves used with pressure taps shall adhere to the requirements stated above for valves and shall be flanged by mechanical joint or push-on. If a three-inch (3") (75mm) tap is desired, a four-inch (4") (100mm) tap shall be made and reduced to a three-inch (3") (75mm) inside of the property line or building.
3. Auxiliary valves used with tapping sleeves shall be flanged by mechanical joint or flanged by push-on. The auxiliary valves and valve boxes shall meet all requirements of Division 500 Section 501.04.D. above.
4. All pressure taps and auxiliary valves shall be bonded and protected from corrosion by coatings, sacrificial anodes and/or other means appropriate to the location and approved by the Engineer. (See Division 500 Section 503 of these specifications)

F. Flushing Hydrants

1. Flushing hydrants may be used on short dead-end water mains where fire protection is not required as allowed by the City. One flushing hydrant may be used at the end of a six-inch (6") (150mm) main, and two flushing hydrants are required at the end of an eight-inch (8") (200mm) main. For dead-end mains twelve inch (12") (300mm) and larger, a regular fire hydrant meeting the requirements of Section 502.02 shall be used.
2. All flushing hydrants shall meet the exterior coating requirements as specified for gray iron and ductile iron fittings (Section 501.04.B.9 and 10.)
3. The two-inch (2") (50mm) service lines, corporation stops, service saddles, curb stops, etc. connected to the flushing hydrant shall meet all requirements of water service material (Division 500 Section 501.04.G.) below.
4. The flushing hydrant length shall provide for a cover of five foot six inch (5'6") (1.7m) over the two-inch lead pipe. The height above ground of the hydrant shall be twenty-one inch (21") (530mm). The hydrant shall have one 2-1/2 inch (63.5mm) hose nozzle with National Standard Thread. The shut-off valve shall have an integral drain to allow the hydrant to drain.
5. The flushing hydrants shall be Mueller Fabricated Post Type Flushing Hydrant A-408, Eclipse Post Type Flushing Hydrant #77 two inch (2") (50mm) or approved equal. The flushing hydrant and cap shall be painted a red enamel as manufactured by Frost Paint Company or an approved equal.

G. Water Services

1. General

All services for ductile iron pipe shall be direct tapped. Service saddles shall be used for all PVC pipe. All services in areas of known or suspected soil contamination shall be of flared copper in accordance with these specifications and direct tapped into ductile iron pipe. All other services shall be polyethylene tubing or compression copper.

2. Copper Service Pipe

- a. Compression fittings may be used for sizes three-quarter inch ($\frac{3}{4}$ ") (20mm) through two-inch (2") (50mm) service lines, curb stops, and corporation stops for all joints. Joints may be flare type for sizes three-quarter inch ($\frac{3}{4}$ ") (20mm) through one inch (1") (25mm). Only compression fittings will be used for services one and a quarter inches ($1\frac{1}{4}$ ") (31.25mm) through two

inch (2") (50mm) unless in contaminated soils. Joints shall be flare type in all sizes in contaminated soil. "Stab" type fittings shall not be allowed.

- b. Copper service pipe shall be seamless and suitable for use as copper underground service connections. Soft copper tubing shall conform to ASTM Class K Specifications and U.S. Government Type K Specifications WW-T-799. All copper service pipe with fittings shall be cathodically protected in accordance to Division 500 Section 503 of these specifications if connected to non-metallic mains.
- c. Curb stops shall be Ford Z22-444, Ford B22-333/444, Mueller H-15200, Mueller H-15204 or approved equal for three-quarter inch (3/4") (20mm) and one-inch (1") (25mm) service, suitable for compression or flared copper inlet and outlet. For one and one-half inch (1 1/2") (37.5mm) and two-inch (2") (50mm) services, curb stops shall be Mueller H-15204, Ford B22-666/777 or approved equal. Ford or approved equal service insulators shall be used on the City side of all curb stops. Where curb stops are located in the sidewalk or concrete, Contractor shall install a cast iron curb box sleeve with each curb box.
- d. Corporation stops shall be Mueller H-15000 or Ford F600 or approved equal for three-quarter inch (3/4") (20mm) and one-inch (1") (25mm) services, with compression or flare type joint for service pipe and threaded inlet end with AWWA corporation stop thread. For one and one-half inch (1 1/2") (37.5mm) and two-inch (2") (50mm) services, Mueller H-15010, Ford F6125 corporation stops or approved equal shall be used with AWWA corporation stop thread.

3. Polyethylene Service Pipe

- a. Polyethylene service tubing shall conform to AWWA specifications for C901-96, SDR 9, PC200. The pipe shall conform to ASTM D-2737 for PE 3408 high-density resin. The outside diameter of all new polyethylene service tubing shall be the same as the outside diameter of type "K" copper service pipe of the same size. Pipe color shall be black for the entire wall thickness. No. 12 electrical wire (three wire) shall be taped to all buried polyethylene water pipes in new developments for future pipe locating purposes. The ends of the locating wires shall be thermite welded to metallic curb stop boxes in accordance to the thermite welding procedures contained in the corrosion protection section (Division 500 Section 503) of these Specifications and also wired into the No. 12 electrical wire taped onto PVC water main piping.

- b. Curb Stops shall be shall be compression fittings with stainless steel inserts. Acceptable curb stops shall be Mueller H-15209, Ford B44-333/777G or approved equal.
- c. Corporation stops shall be compression fittings with stainless steel inserts. Acceptable corporation stops shall be Mueller H-15008, Ford F-1000-3/4G, or approved equal for three-quarter inch (3/4") (20mm) and one inch (1") (25mm) and Mueller H-15013, Ford FB-1000-6/7G, or approved equal for one and one-half inch (1-1/2") (37.5mm) and two inch (2") (50mm).
- d. "Stab" type fittings for polyethylene service pipe shall not be allowed.
- e. Three-part unions shall be compression fittings with stainless steel inserts Mueller H-15403, Ford C-44-333/777G, or approved equal.

4. Service Saddles

All Service Saddles shall be epoxy coated (10-12 mils thick) ductile iron with stainless steel bands, nuts, and washers for corrosion resistance. Ford style FC202, Romac style 202N or approved equal is acceptable. All service saddles and corporation stops connected to non-metallic mains must be protected from corrosion in accordance to Division 500 Section 503 of these specifications.

5. Curb Boxes

Curb boxes shall be five feet six inches (5'6") (1.7m) extension boxes with a one-inch (1") (25mm) upper section, arched pattern Mueller H-10314 or approved equal with stainless steel stationary rod and pin for three-quarter inch (3/4") (20mm) and one-inch (1") (25mm) services. For one and one-half inch (1½") (37.5mm) and two-inch (2") (50mm) services, curb boxes shall be five feet six inches (5'6") (1.7m) Mueller H-10386 or approved equal with a stainless steel stationary rod and pin. Cast iron stationary rods may be allowed by the City in non-corrosive soils.

6. Curb Box Sleeves

Curb box sleeves shall be used where curb stops and boxes are located in sidewalks, other concrete, or asphalt. The curb box sleeves shall be cast iron Mueller H-10342 or approved equal.

H. Granular Materials

- 1. Granular materials furnished for foundation, bedding, encasement, or other purposes, as specified, shall consist of any natural or synthetic mineral

aggregate such as sand, gravel, crushed rock, crushed stone, or slag, that shall be so graded as to meet the gradation requirements specified herein for each particular use (See Drawing 501/1.)

2. Granular Material Gradation Classifications

- a. Granular materials furnished for use in Foundation, Bedding, or Encasement installations shall be:

MATERIAL USE DESIGNATION

<u>Percent Passing Sieve Size</u>	<u>Foundation</u>	<u>Bedding & Encasement</u>
1 inch (25mm)	100	
3/4 inch (19mm)	85-100	90-100
3/8 inch (9.5mm)	30-60	50-100
No. 4 (4.75mm)	0-10	35-100
No. 200 (0.075mm)		0-15

- b. Other gradations may be used if written approval is obtained from the City.
- c. Other approved material for bedding and encasement shall consist of sand, sandy gravel, or fine gravel having a maximum size of three-quarter inch (3/4") (20mm), uniformly graded, and a maximum plasticity of 6 as determined by AASHTO T-89 and T-90.
- d. Certified copies of all sieve analysis and plasticity analysis for the above materials shall be submitted to the City and approved before construction starts. Other sieve or plasticity analysis may be required during construction as directed by the Engineer.

3. Granular Material Use Designations

- a. Granular materials provided for Foundation, Bedding, or Encasement use as required by the Contract, either as part of the pipe item work unit or as a separate Contract Item, shall be classified as to use in accordance with the following:

<u>Material Use Designation</u>	<u>Zone Designation</u>
Granular Foundation	Placed below and to the midpoint of the pipe as replacement for unsuitable or

unstable soils, to achieve better foundation support.

Granular Bedding

Placed from four inches (4") (100mm) below the pipe to the pipe midpoint to facilitate proper shaping and achieve uniform pipe support. When foundation material is required, the granular bedding shall be of foundation material gradation.

Granular Encasement

Placed below an elevation one foot (1') (300mm) above the top of pipe, after pipe installation, for protection of the pipe and to assure proper filling of voids or thorough consolidation of backfill.

4. Select Backfill

- a. Job excavated and imported select backfill material shall be free from debris, organic material, and stones larger than three inches (3") (75mm) in diameter. Contractor shall be responsible, at his expense, for separating debris, organic material, and stones larger than three inches (3") (75mm) in diameter. Select material that the Engineer directs to be used shall be the same gradation as bedding and encasement material. No asphalt chunks or concrete may be used as select backfill.

5. Ground Water Barrier

- a. Low permeability ground water barriers shall be used where directed. Barrier material shall meet soil classification GC, SC, or CL per the Unified Soil Classification System and shall have a liquid limit less than 50. The barrier material shall be compacted to 95 percent of maximum density. Job excavated material meeting one of the above soil classifications and free from stones, organic matter and debris may be used.

501.05 Excavation and Preparation of Trench

- A. When cutting into existing roads, streets, alleys, or other public rights-of-way, the Contractor, shall obtain the proper licenses, cut permits, etc. from the appropriate authority.
- B. When trench excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a spadebitted air hammer, concrete saw, or similar approved equipment to obtain a straight, square, clean break. Cuts shall be located at standard joint locations when possible.
- C. When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces, the Contractor shall strip the cover material to full depth of the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose. New material shall be provided as necessary. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of twelve inches (12") (300mm), whichever is less.
- D. The disturbed area from construction shall be confined within the construction limits.
 - 1. The trench shall be dug only as far in advance of the pipeline as work can be reasonably completed that day. The sides of the trench shall be sloped and/or braced in accordance with current OSHA Rules and Regulations and the trench drained so that workmen can work safely and efficiently. All work must be done in a dry trench and no water will be permitted to discharge down the pipe previously laid. All joints and fittings previously laid shall be immediately plugged. Discharge of pumps shall be to approved natural drainage channels or storm sewers. Wyoming State Engineer groundwater permits and Department of Environmental Quality discharge permits may be required for dewatering.
- E. Pipe crossings under sidewalks or curbs may be made by tunneling, only if approved by the Engineer. If the Contractor elects to remove a portion of the sidewalk or curb, he must use a concrete saw for making neat joints corresponding to existing joints, compact the backfill as specified, and pour a new concrete sidewalk or curb section in accordance with the applicable sections of these specifications.
- F. During excavation, materials suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials shall be stored and retained at least two feet (2') (600mm) or more from the edge of the trench in accordance with Wyoming Occupational Health and Safety Rules and Regulations for Construction.

Excavated material must not be stockpiled over nearby existing parallel trench lines unless adequate precautions are taken by the Contractor to prevent sidewall failure. Ready access to existing fire alarm boxes, fire hydrants, valves, manholes, and other appurtenances must be maintained.

1. When making excavations, the various materials excavated shall be stockpiled separately. All concrete and bituminous materials, any soils that cannot be properly compacted, and all other deleterious materials shall be removed from the construction site and properly disposed of in accordance with applicable laws.
- G. Surface drainage of adjoining areas shall be unobstructed. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in unbackfilled trenches until after the pipe has been placed, tested, and covered with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be reinstalled. Gutters shall be kept clear or other satisfactory provisions made for street drainage at all times.
- H. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings. Bedding material shall be added four inches minimum (4") (100mm) to provide uniform bearing and support for each section of pipe at every point along its barrel length with bell holes dug for bells. Care must be taken to avoid overexcavation. Unauthorized overdepths shall be backfilled with an approved bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to a minimum of 95% of maximum density as determined by ASTM D698. The finished trench bedding beneath the pipe shall be prepared accurately by means of hand tools.
1. The bottom of all excavations shall be neat and clean, and graded accurately to the line and grade shown on the drawings. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material by compacting soil material to at least 95% Standard Proctor, ASTM D698.
 2. If in its natural state the material at the bottom of the trench is soft and, in the opinion of the Engineer, cannot support the pipe, a further depth and/or width shall be excavated as directed by the Engineer and refilled with foundation material to the midpoint of the pipe. Other approved methods may be used to assure a firm foundation.
 3. Foundation material used to dewater the trench or to replace a wet material shall be considered incidental to construction.

- I. Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches (6") (150mm) below the outside barrel of pipe and allow a clear width of six inches (6") (150mm) on each side of the pipe. The space between the bottom of the trench in bedrock or rocky areas and the bottom of the pipe shall be backfilled with suitable granular material in layers of a thickness suitable for compaction and thoroughly compacted before pipe is installed.
 - 1. Blasting the excavation to remove rock, clay, or hardpan shall not be allowed unless absolutely necessary and until the Contractor has notified the Engineer of the necessity to do so. This notification shall in no manner relieve the Contractor of the hazard and liability contingent on blasting operations. The City Engineer shall determine the hours of blasting and the Contractor at his own expense shall repair any damage caused by blasting. The Contractor's methods of procedure relative to blasting shall conform to local and state laws and municipal ordinances, and all the necessary permits shall be obtained.
- J. All excavated material shall be piled within the construction limits or in a location obtained by the Contractor and accepted by the Engineer in a manner that will not endanger the work and that will avoid obstructing sidewalks, driveways, and fire hydrants.
- K. The width of the trench shall be such to provide adequate working room for men to install the pipe in the specified manner. The trench in the pipe zone and to one foot (1') (300mm) above the pipe zone shall be adequate in width to allow for proper compaction but shall in no case be wider than the pipe diameter plus three feet (3') (900mm).
- L. Where the trench is not located near existing utilities, buildings, or other structures, and where water and other conditions permit, the Contractor may omit sheeting and bracing of the excavation. In this event, sides of the trench if in unstable or soft material or five feet (5') (1.5m) or more in depth, shall be sloped to protect the employees working within them in accordance with the current Wyoming Occupational Health and Safety Rules and Regulations for Construction.
- M. The Contractor shall provide safety boxes or sheeting and bracing necessary to confine his work within the construction limits, to provide safe working conditions, to prevent damage and delay to the work, and to prevent the disturbing or settlement of adjacent road surfaces, foundations, structures, utility lines or railroad tracks. The Contractor shall be responsible for the strength and sufficiency of all sheeting and bracing.
- N. Any damage to the work under this contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins, or other reasons due to failure or lack of sheeting and bracing, or improper bracing, or through negligence

or fault of the Contractor in any manner, shall be repaired by the Contractor without delay and at his expense.

- O. Bracing shall be so arranged as to provide ample working space, so as not to interfere with the work, and so as not to place any strain on the structures being constructed, until such structures are of sufficient strength to withstand such strain. No sheeting and bracing shall be removed until the construction has proceeded far enough to provide ample strength for its safe removal.
 - 1. Sheeting or bracing may be left in place in the trench at the discretion of the City Engineer. Any sheeting or bracing left in place shall be cut off approximately three feet (3') (1m) above the top of the pipe and the cut-off portion removed. All sheeting or bracing left in place shall be accurately located and shown on the "Record Drawings" (See Division 500 Section 501.15 of these specifications).

- P. The Contractor shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, shoring, and blasting operations to conform to OSHA regulations.

- Q. The Contractor, if required by site conditions, shall provide a dewatering operation. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.
 - 1. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12") (300mm) or more below the bottom of the excavation.
 - 2. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.
 - 3. The Contractor shall be responsible for the conditions of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
 - 4. In areas where dewatering is required, the Contractor will comply with the following requirements:
 - a. All discharges from dewatering systems, including well points, dewatering wells, pumps in the bottoms of the trenches, etc. will require a permit from the Wyoming Department of Environmental Quality (DEQ). Before starting any construction, the Contractor shall

submit an application to discharge to the DEQ along with a proposed dewatering plan for review. The application shall be submitted on “National Pollutant Discharge Elimination System, Application to Discharge from a Construction Project, Short Form E”. If the dewatering plan is revised during construction, the Contractor shall immediately send a revised plan to the DEQ.

- b. If there is any evidence of hydrocarbon or other contamination of the discharge water the discharge shall immediately cease and the WDEQ shall be notified immediately. The Contractor will then comply with DEQ conditions.
- c. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineer with the application for an excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineer.

R. PCE Testing Requirements

- 1. When working within areas where perchloroethylene (PCE) groundwater contamination is known or suspected, the Contractor shall provide PCE air and water testing services. These services will be required on all excavations where dewatering activities are required and where PCE groundwater contamination is known or suspected. The Contractor shall provide said testing as performed by a certified testing laboratory, and by certified testing methods, and subject to approval of Engineer and City.
- 2. The Contractor shall provide testing services for the following air and groundwater contamination sampling requirements. All results shall be submitted to Engineer and City.
 - a. Air Sampling. One instantaneous test per fifty-feet (50') (16m) of trench shall be taken as the excavation progresses. Results are to be obtained by detector tube test or Organic Vapor Analyzer, or other similar device. These devices must be capable of detecting air quality parameters within the maximum time weighted average (TWA) detection limits for an eight (8) hour period as set by OSHA.
 - b. Should air sampling test results yield concentrations higher than those set by Wyoming Occupational Health and Safety Commission, Contractor is to immediately notify the Engineer, Owner, City, and DEQ and take the appropriate precautions to inform and protect workers and the public from the contaminant. There are several possible methods for protecting against the contamination some of

which include natural trench ventilation, mechanical ventilation, protective clothing, and breathing apparatus for workers and combinations of the above. These protective actions shall be the sole responsibility of the Contractor and he shall use workers, equipment, and methods approved by OSHA for the types of soil contaminants encountered.

- c. One (1) groundwater PCE contamination analysis shall be taken per stationary excavation site, and two (2) tests per pipeline. Detection limits for water testing shall be 0.50 micrograms per liter (0.50 ppb).
- d. Should water sampling test results yield concentrations higher than those set forth by the EPA Manual Guidance of the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program, Dec. 1987, the Contractor is to notify the Engineer, Owner, City and DEQ to help coordinate a course of action.

S. Volatile Organic Compound Sampling

- 1. For those sites with known or suspected soil contamination, the Contractor shall provide for ongoing volatile organic compound (VOC) monitoring of the air (similar to that described for PCE air monitoring) in the breathing zone of the trench and associated working areas. Monitoring shall be performed using an organic vapor analyzer (OVA) or other similar device, capable of detecting air quality parameters within the maximum time weighted average detection limits for an eight-hour period as set by OSHA. All VOC monitoring shall be performed by a trained and competent environmental testing service, subject to prior approval of the Engineer, and Owner, City.
- 2. If and when the VOC level for any breathing zone test exceeds 5.0 milligrams per liter (5.0 ppm), the Contractor shall immediately notify the Engineer, Owner, City and WDEQ and take the appropriate precautions to inform and protect workers and the public from the contaminant. There are several possible methods for protecting against the contamination some of which include natural trench ventilation, mechanical ventilation, protective clothing and breathing apparatus for workers and combinations of the above. These protective actions shall be the sole responsibility of the Contractor and he shall use workers, equipment, and methods approved by OSHA for the types of soil contaminants encountered.
- 3. The necessary ventilation and protective equipment will be expected to be readily available when the need arises if VOC (and PCE) contamination is encountered. The cost of any interruptions or reduction in work efficiency

resulting from VOC contaminated soils (and PCE) shall be born solely by the Contractor.

501.06 Laying of Pipe and Fittings

- A. Contractor shall provide all plant, equipment, labor, and material necessary for the safe and convenient prosecution of the work. Pipe manufacturers installation instructions shall be followed and supplemented by these specifications.
- B. The water pipe and fittings shall be carefully lowered into trench piece by piece by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to the protective coatings and linings. The use of chains is not allowed. Under no circumstances shall water main materials be dumped into the trench. Any damage to pipe coatings shall be repaired with the same materials used for the original coating before laying the pipe.
- C. Before lowering and while suspended, the pipe and fittings shall be inspected for defects and to detect any cracks. Any defective, damaged, or unsound material shall be rejected.
- D. Polyethylene wrap shall be required on all ductile iron pipe. Polyethylene wrap shall also be required on all-metallic fittings, valves, and fire hydrants used in conjunction with either PVC or ductile iron pipe in addition to the cathodic protection specified in Division 500 Section 503 of these specifications.
- E. See Division 500 Section 503 for corrosion control requirements regarding ductile iron pipe, metallic fittings, valves, and fire hydrants.
- F. All foreign matter or dirt shall be removed from the inside of the pipe and fittings before it is lowered into its position in the trench, and it shall be kept clean by approved means during and after laying. An approved snug-fitting stopper or a plug must be installed at the end of each pipe immediately after it is laid and prior to any further excavating, back-casting, or backfilling. All openings along the line of the main shall be securely closed as directed and, in the suspension of work at any time, watertight water stoppers shall be placed to prevent earth, water, or other substances from entering the main.
- G. Trenches for the pipe shall be opened in accordance with the grades indicated in the Contract Documents or to the standard depth of cover of five feet six inches (5'-6") (1.7m), or as directed by the Engineer.
- H. Fine grading of the trench bedding beneath the pipe shall proceed ahead of the pipe installation operation. Unauthorized over-excavation shall be backfilled with bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to 95% of maximum density (Standard Proctor).

- I. Bell holes shall be dug for the pipe bells or couplings and the materials placed along the preceding pipe laid. The pipe shall be supported for the bottom 60 degrees and throughout its length (except for the minimum distance necessary at the bell holes). Bell holes shall be adequate to make the joint, but no larger than necessary, so that maximum support on the prepared bedding beneath the pipe will be provided. The remainder of the pipe shall be surrounded to at least its midpoint by granular bedding material shovel-placed and hand-held machine tamped in maximum six-inch (6") (150mm) layers to completely fill all spaces under and adjacent to the pipe.
- J. No pipe shall be laid in water, on frozen ground, or when the trench conditions are unsuitable for such work.
- K. Long radius curves, either horizontal or vertical, may be laid by deflections at the joints and/or bending of four-inch (4") (100mm) through twelve-inch (12") (300mm) PVC pipe. Fittings shall be provided where shown on the Contract Documents or specified.
- L. Maximum deflections at joints for various types of pipe and fittings shall not exceed the applicable material and joint specifications of AWWA, nor shall the deflection exceed the recommendations of the pipe and fitting manufacturer. When pipe with push-on joints is laid on a curve, the pipe shall be joined in a straight alignment and then deflected and/or bent to the curved alignment.
- M. The bending permitted for four-inch (4") (100mm) through twelve-inch (12") (300mm) PVC pipe shall not be less than the minimum bending radius specified in AWWA C605 nor shall the radius be less than the minimum bending radius recommended by the pipe manufacturer. PVC pipe fourteen-inch (14") (350mm) and over in size shall not be bent.
- N. All plugs, caps, tees, and bends deflecting 11-1/4 degrees or more shall be provided with reaction backing against undisturbed soil with concrete thrust blocks.
- O. Stainless steel rods, harnesses, and retainer glands as approved by the Engineer shall be used for thrust restraint only with the written acceptance of the Engineer. Joint restraining systems shall not be used to replace concrete thrust blocks. No system producing point loadings on AWWA C909 PVC pipe shall be used. All joint-restraining systems shall be cathodically protected in accordance to Division 500 Section 503 of these specifications.
- P. Thrust blocks shall be placed so that the pipe and fitting joints will be accessible for repairs. High, early strength concrete shall be used for all thrust blocks. Testing of lines shall not proceed until concrete thrust blocks are in place at least three (3) days before initial filling of the line. (See Drawings 501/2 and 501/3).

- Q. Thrust walls with stainless steel rods, harnesses, and retainer glands as approved by the Engineer may be used for valve and reducer restraints.
- R. High early strength concrete shall be used for all thrust blocks. The Contractor shall carefully backfill and compact around uncured thrust blocks. All exposed surfaces on uncured thrust blocks shall be covered with polyethylene wrap prior to backfilling. All rebar, stainless steel rods, or straps used in vertical thrust blocks shall be cathodically protected in accordance to Division 500 Section 503 of these specifications. All concrete must have a seven (7) day compressive strength of at least 4000 pounds per square inch (27.6MPa).
- S. The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or coating and so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an acetylene torch shall not be allowed.
- T. When connecting to existing mains, the Contractor shall take every precaution necessary to prevent dirt or debris from entering the existing lines.
- U. If the inside of the pipe or fittings have any caked deposits of dirt, the pipe shall be thoroughly cleaned and disinfected with a chlorine solution in accordance to AWWA C651 "Disinfecting Water Mains" prior to lowering the pipe into the trench.
- V. If any earth, groundwater, surface water, or other substance enters the main, the sections of water pipe affected shall be removed from the trench, thoroughly cleaned of all substances, the gaskets cleaned and replaced, and the sections disinfected with a chlorine solution in accordance to AWWA C651 "Disinfecting Water Mains" prior to reuse. Flushing after the water main is installed shall not be used as a substitute for pipe removal, cleaning, and disinfection.
- W. Tracer/locator wire meeting the requirements of Section 501.04.a.5 shall be taped to the bottom of all buried PVC watermains and fire hydrant extensions for future pipe tracer/locator purposes. Tracer/locator boxes, as specified in Section 501.04.1.5 shall be installed alongside each fire hydrant. A minimum of three feet (3') (900mm) of extra wire shall be provided at each tracer/locator box for each wire.
- X. Installation for pipelines using flow-fill as foundation, bedding, encasement, or backfill material shall be as follows:
1. The mix design for flow-fill shall meet the requirements of Division 200, Section 205.05 Control Density Backfill Mixture Requirements.
 2. Assembly must be done under dry conditions with all joints completely cleaned of dirt and contaminants. Pipe ends and joints shall be kept covered until connection with next pipe segment or fitting. All joints shall be

lubricated in accordance with the manufacturers' recommendations and assembled by pushing the spigot into the bell until the reference mark on the pipe barrel is flush with the end of the bell.

3. The pipe to be embedded in flow-fill can be laid on a four to six-inch (4" to 6") (100mm – 150 mm) bed of washed gravel that has been excavated for the bells so that the pipe is uniformly supported along its entire length or the pipe can be set on four-inch (4") (100mm) high concrete blocks spaced no further than every ten feet (10') (3m). The flow-fill or washed gravel must bear on undisturbed trench bottom. If necessary, Contractor shall stake the pipe to prevent lateral movement or floating during the placement of the flow-fill. The flow-fill must be placed carefully under and around the pipe and extend from undisturbed trench sidewall to sidewall. Placement may be by chute, bucket, or other means to assure that the line and grade of the pipes is maintained. The flow-fill must extend to at least two inches (2") (50mm) above the top of the pipe.

Y. Installation for pipeline crossings using flow fill shall be as follows:

1. Whenever possible, the pipes should be laid so there are no joints or taps within nine feet (9') (3m) of the crossing. The flow-fill shall extend from undisturbed earth at the bottom of the lower pipe to at least two inches (2") (50mm) above the top of the upper pipe and extend from one side of the trench to the other. Pipes crossing one another can be separated by as little as four inches (4") (100mm) when embedded in flow-fill. All sewer services crossing over water mains must be encased in flow-fill in accordance with the provisions of this specification.
2. There shall also be a concrete flow-fill barrier between city lines and high-pressure petroleum lines.

Z. Testing of flow-fill joints.

1. Where sections of existing lines are replaced by new lines, pressure testing of the main shall be performed. If pressure testing is not possible, then verification that the gaskets are properly seated (not buckled out of gasket groove) must be performed. Verification can be performed by inserting a thin metal gauge between the bell and the spigot around the entire circumference of the joint. The edge of the gauge must penetrate only to a reference mark on the gauge that indicates the depth of a properly seated gasket.

501.07 Setting Valves and Valve Boxes

Valves and pipe fittings shall be set and jointed to new pipe in the manner specified for cleaning, laying, and jointing pipe. Valves shall be supported on a concrete foundation at

least eighteen-inches (18") (450mm) square and six-inches (6") (150mm) thick with No. 4 rebar at 12" (300mm) on-center each-way (OCEW). All pressure tap auxiliary valves shall also be supported on concrete blocks.

- A. Whenever possible, a full joint of pipe shall be placed on each side of all six, eight, ten, and twelve-inch (6", 8", 10", 12") (150mm, 200mm, 250mm, 300 mm) valves. Valves requiring restraining devices shall adhere to the following:
 - 1. The valve may be restrained back to tees or crosses using stainless steel rods, harnesses, and retainer glands as approved by the Engineer. For pipe fourteen inches (14") (350mm) and larger, additional pipe joints on each side of the valve may have to be restrained as directed by the Engineer. No valve or pipe joint restraining system producing point loadings on PVC pipe shall be used. All joint restraining systems shall be stainless steel rods and bolts coated with a 100 percent solids epoxy coating (Aquata Poxxy or equal) supplied in two components. The restraining glands, harnesses, and rods etc. shall be coated with a 20 mil minimum thickness coating by brush. The coating shall be protected from backfilling damage during curing by two layers of polyethylene wrap.
- B. Valve boxes shall be firmly supported and maintained centered and plumb over the wrench nut of the valve, with valve box set firmly on valve. Valve box adapters shall be used to keep the valve box centered over the valve. Approved valve box adapters are the Adapters Inc.'s Adapter II or engineer approved equivalent. Acceptance of the valve box will be determined by the successful operation of the valve by the valve box acceptance key. See standard drawing of the valve box acceptance key in standard drawing 501/7. Valve boxes shall be adjusted up or down as needed to achieve final grade. If valve box risers are needed and approved by the engineer, the risers shall be two inches (2") (50mm) or greater in height. Under no circumstances will less than two inches (2") (50mm) in height be used. Extensions must be provided for valves installed with more than five feet (5') (1.5m) of cover. In gravel or unpaved roads, the valve boxes shall be kept four to six inches (4" – 6") (100mm-150mm) below the road surface. In undeveloped areas, a four-inch (4") (100mm) diameter steel post painted blue with the word "water" printed vertically shall be installed three feet (3') (1m) away from the valve box cover, over the water main. The post shall be at least six-feet (6') (2m) long with two feet (2') (0.6m) buried. A similar steel post shall be placed at all bends in undeveloped areas. Posts shall be sandblasted "near white" (SPCC-SP10) and then painted with primer and enamel paint. Plastic valve or bend markers are also acceptable in undeveloped areas. Only plastic valve or bend markers shall be used in highway, street, or roadway right-of- ways.
- C. See Division 500 Section 503 for corrosion control requirements.
- D. All valves shall be installed no more than five degrees (5°) out of plumb.
- E. All valve boxes over eight foot (8') (2.4m) in length will require one (1) piece construction of eight-inch (8") (150mm) Class 150 PVC pipe.
- F. All valve boxes shall be set ¼ " below final street grade.

- G. Full depth concrete encasement around valve boxes in asphalt paved streets is not allowed. Valve boxes may be installed using the standard street section of base course and asphalt to allow for future height adjustment.

501.08 Joint Construction

A. Rubber Gasket "Push-On Joints"

1. Jointing of pipe and fittings with a rubber gasket "push-on" joint shall be as recommended by the manufacturer. The rubber gasket and gasket seat inside the bell shall be wiped clean with a cloth. A thin film of lubricant, shall be applied to the inside surface of the gasket. The lubricant shall be "Blue Lube" brand name, or engineer approved equal. The plain end of the adjoining pipe shall be wiped clean and inserted into the bell a sufficient distance to make contact with the gasket. The plain end shall then be forced "home" by the use of a crow bar, fork tool, or ratchet jack assembly in a manner that does not cause damage to the pipe. Both the spigot and socket must be thoroughly clean, free from tar and other coatings, and rust.
2. The beveled spigot used on the PVC pipe for insertion into push-on fittings or valves should be short and steep (similar to that on ductile iron) to allow for a greater flat sealing surface and to minimize the possibility of the gasket seating on the bevel. The correct rubber ring must be used with the applicable fitting (i.e. - Tyton, Grip-Tite etc.). A reference mark must be used on the pipe to insure the pipe is forced "home" in the fitting or valve. Proper compaction beneath and around push-on fittings and valves is essential. Deflection shall not exceed the requirements of Section 501.06 K, L, and M above and the pipe and fitting manufacturer's recommendations.

B. Mechanical Joints

1. The last eight inches (8") (200mm) outside the spigot end of the pipe and the inside of the bell, fittings, and gate valves shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating) and other foreign matter from the joint and then painted with a soap solution of one-half cup (1/2 cup) (125ml) of food grade soap in one gallon (1g) (4l) of water. The cast iron gland shall then be slipped on the spigot end of the pipe with lip extension of the gland toward the socket or bell. Paint the rubber gasket with soap solution and place on spigot end of pipe with thick edge toward gland. A standard solution furnished by pipe manufacturers may be used instead of the soap solution.
2. The spigot end of the pipe shall be cut straight with no bevel for mechanical joints. All burrs shall be ground off. The rubber gasket shall be carefully placed on the pipe.

3. After the spigot end of a pipe is placed into the bell and pulled home, the gasket shall be pressed into place within the bell evenly around the entire joint. After the gland is positioned behind the gasket, the Contractor shall install all bolts and nuts and tighten them with a torque wrench. Nuts spaced 180 degrees apart shall be tightened alternately to produce equal pressure on all parts of glands.
4. The normal range of bolt torque to be applied to the cast iron bolts in the joints shall be as follows:

Bolt Size Inch (mm)	Range of Torque	
	ft. lb.	(N-M)
5/8 (15mm)	40 – 60	(55-80)
¾ (20mm)	60 – 90	(80-120)
1 (25mm)	70 – 100	(95- 135)
1-1/4 (31.75mm)	90 – 120	(120-160)

If sealing is not attained at the above maximum torque the joint shall be disassembled and reassembled. Overstressing of bolts to compensate for poor installation will not be permitted.

5. Proper compaction beneath and around mechanical joint pipe, fittings, valves, and fire hydrants is essential. Deflection shall not exceed the requirements of Section 501.06 K, L, and M above and the pipe and fitting manufacturer's recommendations.

501.09 Backfilling and Grading

- A. All excavation in trenches shall be backfilled to the original ground surface or to such grades as specified or as shown on the drawings. The backfill shall begin as soon as practical after the pipe has been placed and shall be carried on as rapidly as the protection of the balance of the work shall permit.
 1. No pipe shall be covered before the Project Representative or the Engineer has observed and approved the pipe. If any piping or appurtenance is covered without the approval of the Engineer or Project Representative, at the discretion of the Engineer, the Contractor will be required to re-excavate to expose the covered materials. The cost of exposing those materials and then backfilling and recompacting will be at the Contractor's expense regardless of the condition of the pipe and/or the materials under question.
 2. The Contractor shall completely backfill all excavations before stopping work at the end of each day. Open excavations (fenced or unfenced) shall not be

allowed overnight or on weekends at any site after work has stopped for the day unless approved by the City.

- B. Complete cleanup shall proceed directly behind the backfilling operation to accommodate the return to normal conditions. Should the Contractor, in the City's opinion, fail to pursue diligently the backfilling and cleanup, the amount of work on which complete cleanup has not been accomplished shall be limited to one thousand lineal feet (1,000') (300m) for the entire job. The Contractor shall have sufficient equipment on the job to assure timely backfill and cleanup at all times.
- C. Backfilling and compacting shall be done to meet Division 500 Section 501.09L of these specifications. Depositing of the backfill shall be done so the impact of falling material will not injure the pipe or structures. Grading over and around all parts of the work shall be done as directed by the City.

Where excavations occur in unpaved surfaces, such as alleys but not previously turfed areas, the area shall be restored by placing a minimum of two inches (2") (50mm) of stabilized gravel on the surface of the excavation. Stabilized gravel shall be equal to material meeting coarse aggregate for minus three-fourths inch (3/4") (20mm) as specified in the City Standard Specifications for Street Construction.

- D. Granular bedding material shall be deposited in the trench simultaneously on both sides of the pipe for the full width of the trench to a height at least to the mid-point of the pipe. The bedding material shall be shovel placed and hand-held machine tamped in maximum six-inch (6") (150mm) layers to completely fill all spaces under and adjacent to the haunches of the pipe. Encasement material will then be placed around and over the pipe to a height of at least twelve inches (12") (300mm) above the top of the pipe, but need not be hand-placed. Granular encasement material, as specified, must be used for all pipe.
- E. Succeeding layers of backfill above the twelve-inch (12") (300mm) level may contain coarse materials not exceeding three inches (3") (75mm) in the largest dimension, but shall be free from large pieces of rock, frozen material, concrete, roots, stumps, tin cans, rubbish, and other similar articles whose presence in the backfill would, in the opinion of the Engineer, cause settlement of the trench or damage to the pipe. Whenever select material that exists in place in the upper four feet (48") (1.2m) of the finished grade of the paved or traveled portions of the street or roadway, is removed by the trench excavation, the Contractor shall replace said material (or material of equal quality) as backfill in the upper four feet (48") (1.2m) of the finished grade. Where select material does not exist in place as described above, the Contractor shall provide and place sufficient select backfill to stabilize the finished grade as directed by the Engineer.
- F. Backfilling shall be done in lifts of uniform layers that will produce the required compaction. Each lift shall be completely compacted over the full width of the

excavated area. Compacting shall continue until the specified relative compaction has been attained or until no more settlement occurs. Water jetting of backfill shall not be permitted.

- G. Groundwater barriers shall be placed at a maximum of three hundred feet (300') (90m) intervals or where directed by the Engineer. These shall be provided to interrupt the passage of water through the foundation, bedding, encasement, and select backfill material. Low permeability ground water barriers shall be used where directed. Barrier material shall meet soil classification GC, SC, or CL per the Unified Soil Classification System and shall have a liquid limit less than 50. Job excavated material meeting one of the above soil classifications and free from stones, organic matter and debris may be used. The barriers shall be compacted to 95% of maximum density (Standard Proctor) the full depth of the granular material, the full trench width and a minimum of three-feet (3') (1m) long.
- H. Special attention shall be given to the compaction operation performed around all manholes, valve boxes, curb boxes, other structures, and utilities by the use of pneumatic tampers, plate tampers, or plate vibrators to obtain the required compaction requirement.
1. Structure backfilling shall cover manholes, valve boxes, curb boxes, and any other structure encountered during the course of the work. Fill around structures shall consist of trench backfill meeting the requirements of bedding and encasement material or select backfill material. Fill material shall be spread and compacted to provide continuous and uniform support around the structure.
 2. Do not place fill when the surface to be filled is snow covered or frozen. Do not place frozen fill.
 3. Fill around concrete structures shall commence only after concrete has attained 80% of the ultimate compressive strength specified. Remove all form materials, concrete spills, and trash from around the structures before placing fill. Where backfilling on both sides or around the perimeter of a structure is required, place the backfill and compact simultaneously at the same elevation on opposite sides or around the perimeter in lifts.
 4. Place fill material in eight-inch (8") maximum lifts and compact to at least 95% density for cohesive soils and 70% relative density for non-cohesive soils. The moisture content shall be plus or minus 2% of optimum.
- I. Water service trenches shall be compacted in the same manner as the water main trenches. In streets open to traffic, service trenches must not be left open overnight. In areas where curb and gutter exist, sufficient curbing shall be removed to allow this compaction over the entire disturbed area.

- J. All deficiencies in the quantity of material for backfilling the trenches or for filling depressions caused by settlement shall be supplied by the Contractor. Any excess material shall be hauled away and disposed of in a legal manner at no additional compensation.
- K. No waste material or debris shall be deposited on any public or private property without the written permission of the Engineer and property owner. Waste material and debris shall include, but not be limited to trees, stumps, pieces of pipe, pieces of concrete, pieces of asphaltic concrete, tin cans, or other waste material from the construction operations. Disposal of this material shall be the responsibility of the Contractor.
- L. The in-place density of the compacted soil shall be determined by the Engineer or a soils testing agency using either ASTM standard test method D1556-82 (sandcone), AASHTO T 238-97, or ASTM standard test method D2722-81 (nuclear). The maximum density of the soil shall be determined by ASTM standard test method D698 (standard proctor). The in-place density must not be less than the following percentages of the maximum density in paved areas, areas to be paved, and graveled areas:
1. 95% compaction from twenty-four inches (24") (600mm) above top of pipe to the finished surface, except that in no case shall this 95% compaction zone be less than forty-eight inches (48") (1200mm) deep.
 2. 90% compaction from pipe zone to start of 95% compaction zone.
 3. The compaction required outside paved areas, outside areas to be paved or outside graveled areas shall be 90%.
 4. The compacted backfill shall have a moisture content of $\pm 2\%$ of optimum moisture.
- M. The Engineer shall determine the frequency and number of tests to be conducted to measure the gradation, density, and moisture of the backfill. Minimum testing frequency is as follows:
1. Gradation Test
 - a. Pipe Zone Material. One initial gradation test for each type of material plus one additional test for each five thousand cubic yards (5,000 yds³) (3,750 m³) or portion thereof placed of each material.

- b. Foundation Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
- c. Bedding and Encasement Material. One initial gradation test for each type of material plus one additional test for each ten thousand cubic yards (10,000 yds³) (7,500 m³) or portion thereof placed of each material.
- d. Select Backfill Material. One initial gradation test for each type of material plus one additional test for each ten thousand cubic yards (10,000 yds³) (7,500 m³) or portion thereof placed of each material.
- e. All gradation tests shall be the responsibility of the Contractor using an approved and certified soils testing laboratory, acceptable to the Owner and Engineer. The Contractor shall be responsible for all costs associated with gradation testing.

2. Density and Moisture Test.

- a. Pipe Zone Material. One test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
- b. Foundation Material. One test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
- c. Bedding and Encasement Material. One test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
- d. Select Backfill Material. One test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
- e. Job Excavated Select Backfill Material. Tests shall be taken as arranged by the Engineer.
- f. Unless otherwise indicated in the Contract Documents, density and moisture tests shall be the responsibility of the Engineer. The Contractor shall cooperate with the Engineer or the soils testing agency in taking density and moisture tests.

- N. When the trench excavation for the water main and appurtenances is within the rights-of-way of state or county highways, the backfilling of the trench, compaction of materials, subgrade preparation and surfacing shall be done in strict accordance

with the requirements and specifications of the authority having jurisdiction or as required by these specifications, whichever is more stringent.

- O. In all cases, the Contractor shall blade and compact the roadway after the trench has been backfilled, so that it shall be passable to traffic at all times. The Contractor shall maintain the roadway in a condition acceptable to the City at all times until final acceptance of the entire work by the City.
- P. The Contractor shall also blade and maintain all detours and bypasses. All maintenance work shall be done at no additional compensation. In addition to the blading and maintenance requirements specified, the Contractor shall provide at least one tank truck with pressurized spray bars for spraying water on the streets to control the dust. Dust control shall be required as necessary on all areas disturbed by construction and on all detours and bypasses.
- Q. The Contractor is responsible for the complete maintenance of his work at all times. If he fails to provide proper maintenance, and safety or nuisance conditions arise, it is expressly understood that City crews may be directed by the City to provide essential maintenance, and that such work will be done at the expense of the Contractor.
- R. The Contractor shall remedy at his own expense any defects that appear in the backfill following completion and during the warranty period.

501.10 Service Connections

- A. General
 - 1. It shall be the duty of the Contractor to keep an accurate record of service connections as to location of the water main tap, location of curb stop, elevation of water main tap, size of connection provided, and other pertinent data and to include this information on the record drawings. Water main tap locations shall be recorded with respect to the survey line stationing. Curb stop locations shall be tied to houses, other existing structures, or lot corners.
 - 2. All curb stops shall be located at the property line or right-of-way boundary if the water main is located in an easement. In the case of all new additions and construction, the developer and individual lot owners shall be responsible for protecting all curb stops and bringing the curb stops up to grade following lot construction and landscaping.
 - 3. Curb box sleeves shall be used where curb stops and boxes are located in sidewalks, other concrete, or asphalt.

4. See Division 500 Section 503 for corrosion control requirements in addition to the coating requirements indicated in Section 501.04.G.
5. Groundwater barriers shall be placed on service lines at the property line. The barriers shall be compacted to 95% of maximum density (standard proctor) the full depth of the granular material, the full trench width, and a minimum of three feet (3') (1m) long.
6. All abandoned or unused water service lines must be removed and plugged at the main.

B. Building Service Connections to New Waterlines

1. Water services shall be installed on the lot centerline wherever possible. Service pipe shall be extended from curb stop to back of utility easement by Contractor. If pipe is extended, it shall be sealed with a soldered cap for copper pipe and a polyethylene cap for polyethylene pipe at its end. The end of the pipe shall be clearly marked by a rebar, with a rubber-protected cap, extending from the curb stop to at least three feet (3') (1m) above the ground. The service line location shall also be marked in the concrete curbwalk by an arrow with the letter "W". The Contractor shall provide a curb box for the curb stop extended to final grade.
2. Services shall have a minimum of five feet six inches (5'6") (1.7m) of cover and shall be laid as shown on the detail drawings. Expansion loops shall be provided near the tap and shall be laid horizontally. The service line shall not extend above the top of the pipe near the corporation stop.
3. The Contractor shall make all taps into the top one-half of the water main at an angle of not more than 30 degrees from the horizontal and install corporation stops. Service pipe shall be installed without joints between the corporation stop at the water main and the curb stop unless otherwise accepted by the Engineer. One and one-half inch (1½") (37.5mm), one and one-quarter inch (1¼") (31mm), and two-inch (2") (50mm) services shall have a 45-degree bend connected to the corporation stop to provide for a horizontal expansion loop.
4. For PVC water lines, no services shall be tapped directly into the pipe with a corporation stop. All taps shall be made using approved service saddles with corporation stops. All taps shall be tapped with a core bit. No spade bits are allowed. Taps shall be located at least one foot (1') (300mm) from the pipe ends. If two (2) insertions are made, one on each side of the main, they shall be separated (measured along the pipe length) by at least one foot (1') (300mm). Multiple insertions made on the same sides of the main should be staggered as well and separated by at least one foot (1') (300mm). PVC pipe should not be tapped in any area that shows discoloration (sunburning).

5. When the Contractor chooses to supply residents or businesses with water during construction activities by temporarily constructing water piping (rather than keeping existing water main in use during construction operations), Contractor shall chlorinate such temporary piping in accordance with the requirements of the AWWA C651 and supply all materials except fire hydrant meters that will be provided by the City. City personnel will take high chlorine and low chlorine tests prior to the Contractor putting his temporary piping in service. It is not anticipated that City staff will take bacteria tests, but the City reserves the right to take such tests as it deems appropriate. The City may require backflow prevention devices be installed.
6. There shall be no mechanical boring devices used for new or existing services where conflicts with other utilities exist.

C. Building Service Connections to Existing Water Lines

1. The City shall make all taps for the Contractor on all existing water lines.
2. The Contractor shall be responsible for obtaining a street cut permit, laying out and excavating the trench, protecting all stops and service pipes, and backfilling the excavation in an approved manner. Contractor shall adhere to OSHA trenching and shoring rules and regulations.
3. The Contractor will not be required to pressure test existing water service pipe and curb stops that are to remain in service. Visual test (no leaks or drips) or auditory test will be used in place of pressure testing.
4. Contractor shall pressure test where complete new water service pipe and new curb stop are installed.
5. All abandoned or unused service lines must be removed and plugged at the main.

D. Townhouse Manifolds

1. All townhouse "manifold" systems shall meet the material and installation requirements of the "Water Distribution Facilities Design Standards", these specifications, and the Uniform Plumbing Code as adopted by the City of Casper.

501.11 Connection of New Water Mains into Existing Water Mains

- A. Whenever possible, water main connections shall be made under pressure. The City shall make the tap for the Contractor. The Contractor may purchase the pressure tap

material, auxiliary valve and box if desired in accordance to Sections 501.04.D and E. The Contractor shall obtain any needed street cut permits, shall excavate and expose the water line, provide protective coating as indicated in Section 501.04.E., pour the thrust block behind the tap, provide corrosion control as directed in Division 500 Section 503, and backfill and grade the trench.

- B. When it is not possible to make connections under pressure, prior to connecting to existing water mains, the Engineer and the City must be notified. Any residents who will be affected by the shutting off of water shall be given written advance notice by the Contractor as to when and for how long service will be interrupted. The notice shall be delivered at least 24 hours (48 hours for commercial locations) in advance of shut-off and shall state the Contractor's name, address, and telephone numbers (for both business and after hours). The City shall be notified 48 hours in advance of any shut-offs. All shut-off times must be agreed by the City prior to notices being issued, and work must not be undertaken unless City personnel are present. All valves existing or new shall be operated only by the City unless under the direct supervision of on-site City personnel. Prior to connecting to existing water mains, the Contractor shall have all men, materials, and equipment ready to do the work, so as to keep the shut-off time to a minimum. As soon as possible after making the connections, the City shall flush the new main so as to prevent any contamination of the existing facilities.
- C. All new valves, fittings, and pipe that cannot be disinfected by the standard chlorination method, shall be completely sprayed or swabbed internally and externally with a strong chlorine solution (5% hypochlorite solution) immediately before installation into the existing water main.
- D. The Contractor shall construct temporary thrust blocks or thrust restraints where necessary to expedite resumption of service in existing lines before permanent concrete reaction blocks have fully cured. The Engineer shall approve the design of temporary blocks and restraints before connection work begins.
- E. All valves shall be installed in the closed position.
- F. Contractor may deflect the new water main piping and fittings within the limits of Section 501.06 K, L, and M above and the pipe and fitting manufacturer's recommendations to make the final connection with the existing water main. Do not bend or deflect existing mains. Ensure proper compaction beneath the existing main at all tie-ins. Provide the fittings as necessary to achieve proper alignment. Remove the existing main as necessary to make the connection. The Contractor shall submit to the Engineer for approval a detailed plan for connections to existing mains detailing fittings, sequencing, and maximum bending and deflections being used prior to start of work.

501.12 Disinfection and Testing Mains

A. General

1. The Contractor shall first pressure test the main, then disinfect, and then bacteriologically test all mains at no additional compensation regardless of existing conditions. All water service lines and fire sprinkler lines four- inch (4") (100mm) and larger shall be pressure tested, disinfected, and bacteriologically tested.

B. Pressure Test – Leakage Test

1. After the pipe has been laid (and before disinfection and bacteria testing), including fittings, valves, corporation stops, services, and hydrants, and the line has been backfilled in accordance with the section on "Backfilling and Grading" of these Standard Specifications, each valved section, unless otherwise directed by the Engineer, shall be subjected to hydrostatic pressure of not less than one hundred fifty pounds per square inch (150 PSI) (1035 kPa) at the point of testing.
2. All concrete reaction block shall be in place at least five (5) days before the initial filling of the line or pressure testing unless high early strength concrete is used which will require three (3) days in place.

PRESSURE TEST REQUIREMENTS

- a. Test at 150 pounds per square inch (1035kPa).
 - b. Be of at least two-hour duration.
 - c. Not vary more than 5 psi (35kPa) at any time during the test.
 - d. Not exceed a leakage of 0.175 gallons per inch diameter per 1000 linear feet (0.662L per 25 mm diameter per 300m) of main during the two hour test period.
 - e. All valves shall be tested at 150 psi (1035 kpa) for two hours.
3. Pipes, fittings, valves or hydrants, or other materials which are discovered to be defective by pressure testing, shall be removed and replaced by the Contractor with new material at his expense. The test shall be repeated until the water main passes the pressure test and is accepted by the Engineer. Before making the pressure test, valves controlling hydrant lead pipes shall be checked to ensure that they are open.

4. Each valved section of pipe including all services shall be slowly filled with water, and the specified test pressure, measured at the lowest point of elevation, shall be applied by means of a pump connection. The Contractor shall furnish the pump, water meter, gauges, and all other necessary apparatus. Gauges and measuring devices must meet with the acceptance of the Engineer and the necessary pipe taps made as directed. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, if necessary, at points of highest elevations. The taps shall be regular service corporation stops (with service saddles for PVC pipe) adhering to Section 501.04.G. After use, the corporation stop shall be closed and capped. All taps shall be provided with corrosion protection as indicated in Division 500, Section 503. All taps made to expel air shall be at the Contractor's expense.
5. The introduction of any substance into the water used for testing with the intent of sealing leaks will not be permitted.

C. Disinfecting Water Mains

1. After construction and pressure testing is complete, and before being placed into service, all water lines shall be disinfected with chlorine. AWWA C651 is the standard of reference to be used.
2. Precautions shall be taken at all times during construction to protect pipe interiors, fittings, and valves from contamination.
3. Preliminary Flushing
 - a. The mains shall be flushed prior to disinfection except when the tablet method is used. The discharge of flushed water shall not cause erosion or damage to streets, sidewalks, vegetation, or other property. The flushing velocity shall not be less than 2.5 ft./sec. (0.8m/s) and shall be done in accordance to the following:

Required Openings to Flush Pipelines * (40 psi (275 kPa) Residual Pressure)

Pipe Size in. (mm)	Flow Required to Produce 2.5 fps Velocity in Main gpm (l/m)	Size of Tap, in (mm)		Number of Hydrant	
		1 ½ (38)	2 (50)	2 ½ -in (63.5mm)	
		Taps on Main		Hydrant Outlets	
4 (100)	100 (380)	1		1	
6 (150)	200 (760)	1		1	
8 (200)	400 (1515)	1		1	
10 (250)	600 (2275)	2		1	

12(300)	900 (3410)	2	2
16(400)	1,600 (6055)	4	2

With 40 psi (275 kPa) residual pressure, a 2-1/2" (63.5 mm) hydrant outlet nozzle will discharge approximately 1,000 gpm (3785 l/m) and a 4-1/2" (112.5mm) hydrant outlet nozzle will discharge approximately 2,500 gpm (9600 l/m).

Taps on the main shall be regular service corporation stops (with service saddles for PVC pipe) adhering to Section 501.04.G. After use, the corporation stop shall be closed and capped. All taps shall be provided with corrosion protection as indicated in Division 500 Section 503. All taps made for flushing and/or sampling purposes shall be at the Contractors expense.

- b. A combination flushing and sampling tap useful for mains up to and including eight-inch (8") (200mm) diameter can also be temporarily installed (see Drawing 501/6).
 - b. Flushing hydrants, meeting the requirements of Section 501.04.F, are acceptable for flushing up to and including eight-inch (8") (200 mm) diameter mains.
 - c. Preliminary flushing is no substitute for preventive measures taken during pipe laying. Some contaminants in caked deposits resist flushing at any velocity. Contractor shall adhere to Section 501.06.
 - d. All fire sprinkler lines shall be flushed in accordance to the requirements of NFPA 13 "Standards For The Installation of Sprinkler Systems". Fire Department personnel shall witness sprinkler line flushing. All fire lines shall be pressure tested, high and low chlorine residual tested, and flushed.
 - e. If the residual pressure will be less than 40 psi (275 kPa), flushing devices such as temporary flushing pipes up the diameter of the pipe, and/or temporary pumping units may have to be used. All substitute flushing arrangements must be approved for use by the Engineer.
 - f. All preliminary and final flushing water shall be metered or, if allowed by the Engineer, shall be estimated. The Contractor shall furnish all fittings and hoses necessary to connect the flushing arrangements to water meters.
4. Chlorine Application - The forms of chlorine suitable for waterline disinfection are hypochlorite solutions, and calcium hypochlorite tablets.

a. Tablet Method

- 1) This is suitable for short extensions (up to twenty five hundred feet (2500') (750m)) and small diameter mains (up to sixteen inch (16'') (400mm)). This method requires the main to be scrupulously clean and shall not be used if trench water or foreign material enters the main.
- 2) Tablets shall be placed in each section of pipe, hydrants, hydrant branches, and other appurtenances. All tablets in the main shall be attached by adhesive (Permatex Form-A-Gasket No. 2 or approved equal which are FDA approved for use in contact with edible products) to the top of the pipe in accordance to the following:

Length of Section ft. (m)	Diameter of Pipe (in.) (mm)					
	4(100)	6(150)	8 (200)	10 (250)	12 (300)	16 (400)
13 or less(4)	1	1	1	2	3	4
18 (5.5)	1	1	2	3	4	6
20 (6)	1	1	2	3	4	6
30 (9)	1	2	3	4	6	10
40 (12)	1	2	4	5	7	13

* Based on 3-1/4 g available chlorine per tablet.

Crushed tablets shall be placed in the annular space of joints.

- 3) After the installation is complete, the main shall be filled with water at no more than 1 ft/sec (0.3 m/s). The water shall have a minimum chlorine concentration of 25 mg/l and shall remain in the main at least 24 hours. At the end of the 24 hours, the residual chlorine concentration must be at least 10 mg/l. Valves shall be manipulated so that the chlorine solution in the line will not flow back into the line supplying the water. The Engineer shall take samples at the end of the 24-hour period to ensure that the residual chlorine concentration is at least 10 mg/l.

b. Continuous Flow Method

- 1) Chlorine feed shall be proportional to the rate of flow into the pipe so that the chlorine concentration in the water is maintained at a minimum 25 mg/l. The following table gives

the amount of chlorine required to treat one hundred feet (100') (30m) of pipe using pure chlorine and a 1% solution:

Pipe size in. (mm)	100 Percent Chlorine lb.(g)	One Percent Chlorine Solutions gal.(l)
4 (100)	0.013 (6)	0.16 (0.6)
6 (150)	0.030 (14)	0.36 (1.4)
8 (200)	0.054 (24)	0.65 (2.5)
10(250)	0.085 (39)	1.02 (3.9)
12(300)	0.120 (54)	1.44 (5.4)
16(400)	0.217 (98)	2.60 (9.8)

- 2) The chlorine shall remain in the main at least 24 hours and must have a residual concentration of at least 10 mg/l at the end of 24 hours. Valves shall be manipulated so that the chlorine solution in the line will not flow back into the City water main supplying the water. The Engineer shall take samples at the end of the 24-hour period to ensure that the residual chlorine concentration is at least 10 mg/l.

c. Slug Method

- 1) This is suitable for use with large diameter mains. Chlorine shall be fed into the pipe at a proportion to the rate of flow such that the chlorine concentration in the water will be at least 100 mg/l. Chlorine shall be applied continuously and for enough time to develop a "slug" of chlorinated water that will, as it moves through the main, expose all pipe to the chlorine concentration of 100 mg/l for at least three (3) hours. As the chlorinated water moves through the line, related valves and hydrants shall be operated so as to disinfect appurtenances and branches.

5. Final Flushing

- a. After tests have confirmed the chlorine residual is sufficient after the required detention time, the heavily chlorinated water shall be flushed from the system until the system is free from excess chlorine. All flushing shall follow the same requirements as those given for preliminary flushing. All flushing shall be done by or under the direction of City personnel. The final flushing of chlorinated water shall not be allowed to enter storm sewers, streams, vegetation, or drainages until the

chlorine has dissipated in order to protect aquatic life. Appropriate dechlorination by chemical methods by the Contractor may be necessary.

The Engineer or the City shall take samples after final flushing to ensure that the system is free from excess chlorine.

6. Sampling

- a. After final flushing and before the new water main is connected to the distribution system, acceptable bacteriological samples shall be collected from the new main. Samples will not be collected on Fridays through Sunday unless special arrangements are made with the Engineer and the City. At least one bacteriological sample shall be collected from every twelve hundred feet (1200') (366m) of the new water main or at the end of each valved section whichever is less, plus one from each end of the line and at least one from each branch. All samples shall be collected by the City and shall be tested for bacteriological quality in accordance with the most recent edition of *Standard Methods for the Examination of Water and Wastewater* by a certified laboratory, and shall show the absence of coliform organisms. A standard heterotrophic plate count may be required at the option of the Owner or Engineer. Turbidity analysis may also be required by the Owner or Engineer to ensure the cleanliness of the new mains. All expenses associated with first-time bacteriological sampling, heterotrophic plate counts, and turbidity samples shall be at the cost of the City. All subsequent costs for retesting because of test failures shall be charged to the Contractor.
- b. Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by the most current edition of *Standard Methods for the Examination of Water and Wastewater*. No hoses, fire hydrants, or permanent flushing hydrants shall be used in the collection of samples. Water service lines may be used for collection of samples. A combination flushing and sampling tap useful for mains up to and including eight-inch (8") (200mm) diameter can also be temporarily installed (see Drawing A6). As another alternative, a corporation stop (with service saddle for PVC pipe) adhering to Section 501.04.G. may be installed with a copper-tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use and the corporation stop closed and capped. The corporation stop and service saddle shall be provided with corrosion protection as indicated in Division 500, Section 503 in addition to the coating requirements indicated in Section 501.04.G. All taps made specifically for sampling and/or flushing purposes shall be at the Contractor's expense.

- c. If trench water has entered the new main during construction or, if in the opinion of the Owner or Engineer, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately two hundred feet (200) 61m) and shall be identified by location. All costs of sampling because of trench water, dirt, or debris in the main shall be charged to the Contractor. Additional samples shall be taken of new mains where the water has stood in the new main for at least 16 hours after final flushing has been completed.
 - d. At least forty-eight (48) hours notice shall be given to the City by the Contractor for bacteriological sampling in commercial and residential service areas.
7. Rechlorination
- a. All flushing water costs and other City costs associated with the need to rechlorinate and/or reflush the mains to obtain satisfactory bacteriological tests shall be charged to the contractor.
8. Procedure After Cutting into or Repairing Existing Mains
- a. The interior and exterior of all pipes and fittings shall be completely sprayed or swabbed with a strong chlorine solution (5% hypochlorite solution) immediately before installation. Thorough flushing shall be started as soon as repairs are finished. Bacteriological samples shall be taken after repairs are finished and flushing is complete.
 - b. It will be at the discretion of the City if bacteriological samples and flushing will be required.

501.13 Separation of Water Mains and Sewers

- A. Minimum horizontal separation shall be ten feet (10) (3m) where the invert (bottom) of the water main is less than eighteen inches (18") (450mm) above the crown (top) of the sewer line. Minimum vertical separation shall be eighteen inches (18") (450mm) at crossings. Joints in sewers at crossings shall be located at least ten feet (10') (3m) from water mains. The upper line of a crossing shall be specially supported. Where vertical and/or horizontal clearances cannot be maintained, the sewer or water shall be placed in separate conduit pipe.
- B. Flow fill may be used in lieu of the separation requirements listed above in accordance with section 205.05.

501.14 Inspection and Acceptance

A. Preliminary Acceptance

1. Prior to preliminary acceptance of a water distribution system, regardless of ownership, the following inspection tests shall be made and certified for each section of water line.
 - a. Gradation tests. Copies of the test results shall be enclosed as an attachment to the "Certificate of Completion".
 - b. Density and moisture tests. Copies of the test results shall be enclosed as an attachment to the "Certificate of Completion".
 - c. Pressure tests - leakage tests. Copies of the test results shall be enclosed as an attachment to the "Certificate of Completion".
 - d. Disinfection and bacteriological tests. Copies of the test results shall be enclosed as an attachment to the "Certificate of Completion".
 - e. Operation checks of all valves, hydrants, and service connections. Fire Department approval is needed for all hydrant nozzle alignments.
 - f. The City shall determine the acceptable alignment of all valve boxes using an alignment tool as shown in standard drawing 501/7. All boxes not meeting the acceptable alignment standards shall be reset by the contractor.
2. Items c. and d. above shall be performed only after complete backfill and compaction; items e. and f. shall be performed after an all-weather roadway is completed and complete easement restoration is accomplished.
3. The "Certificate of Completion" and "Record Drawings" shall be submitted to the City prior to preliminary acceptance.

B. Final Acceptance

1. Final acceptance will not take place until preliminary acceptance is obtained and all paving and curbside is completed.
2. Before final acceptance of any water line, the following inspections shall be made:
 - a. Acceptable alignment of all valve boxes using an alignment tool as shown in standard drawing 501/7. All boxes not meeting the acceptable alignment standards shall be reset by the contractor.
 - b. Operation and height of all hydrants.

3. All punch list items must be completed prior to final acceptance.
4. The warranty period shall not start until final acceptance is obtained and a complete set of "Record Drawings" is submitted to the City.-

501.15 "Record Drawings"

- A. "Record Drawings" shall be submitted to the City prior to preliminary acceptance of the construction project. "Record Drawings" shall include, in addition to construction drawings and details, "as built" information where it differs from construction drawings and locate information including horizontal and vertical coordinates in the datum established by the City for the Geographical Information System.

501.16 Standard Detail Sections

- 501/1 Typical Street Cut Section (Asphalt Surfacing)
- 501/2 Standard Thrust Block Detail
- 501/3 Typical Water Main Lowering Detail
- 501/4 Water Service Line Detail
- 501/5 Combination Air Release/Vacuum Relief Manhole Detail
- 501/6 Temporary Combination Flushing and Sampling Tap Detail

DIVISION 500

SECTION 502

FIRE HYDRANTS

502.01 Description

- A. The work covered by this Section consists of furnishing all equipment, labor, and materials necessary for the installation of fire hydrants to be completed in accordance with the following specifications and dimensions described.

502.02 Materials

- A. Fire Hydrants shall conform to "Standard Specifications for Fire Hydrants for Ordinary Water Works Service", AWWA C502, and modifications herein specified.
- B. Hydrant length shall provide for a cover of five foot six inches (5'6") (1.7m) over the lead pipe, or five foot nine inches (5'9") (1.75m) from the centerline of the hydrant inlet. The center of the hose nozzles on the hydrant should be eighteen inches (18") (450mm) above finished grade. Hydrants shall have two, two and one half-inch (2½") (63.5mm) hose nozzles and one four and one half inch (4½") (112.5mm) pumper nozzle to fit National Standard Thread. The main valve shall have a five and one fourth-inch (5¼") (133mm) opening, inlet connection six-inch (6") (150mm) mechanically jointed or slip-on and a one and one half-inch (1½") (37.5) pentagon operating nut with weathershield opening counterclockwise. The drain channel shall be brass or bronze lined. In areas where the hydrant base is installed below ground water, the drain shall be plugged using manufacturer seat system for plugging drains of fire hydrants. The hydrant shall be marked with a metal tag to indicate the requirement to pump the hydrant after use.
- C. The hydrant valve shall be of the type to open against main pressure. The valve shall have a bronze seat ring with valve plate and with specially processed valve rubber, and shall have a tapered seat for positive closure. This entire mechanism shall be removable for repairs or replacement through the barrel without excavation.
- D. Outlet nipples shall be bronze, mechanically fastened to the nozzle section. Hose and steamer caps shall be provided with rubber gaskets and pentagon nuts with cap chains.

- E. "O" ring seals shall be provided to prevent water from reaching the operating mechanism. The operating mechanism shall be lubricated through an opening in the operating nut or bonnet.
- F. All moving parts are to be bronze or bronze bushed.
- G. A traffic collision breakoff feature shall protect the barrel and stem in case of impact.
- H. All parts of hydrants furnished shall be interchangeable with all other hydrants of the same size, model, and make without special fittings.
- I. Hydrants shall be Mueller Super Centurion 250 A-423 or modified Waterous Pacer WB67 with pentagon nut caps, and shall be painted with an off white enamel as manufactured by Frost Paint Company or an approved equal. The caps shall be primed with gray primer for future color-coding in the field. Hydrants may be push-on or mechanical joint.
- J. Mechanical joint bolt and exterior coating requirements shall be the same for fire hydrants as for the fittings defined in Division 500 Section 501.04.B.9. In all soils, the hydrant shoes shall be epoxy coated and furnished with stainless steel bolts. The fire hydrant barrel does not need to meet the external coating requirement, but must be polywrapped.

502.03 Hydrant Installation

- A. Immediately before installation of a hydrant, the following operations shall be performed:
 - 1. The hydrant shall be thoroughly inspected.
 - 2. The hydrant interior shall be thoroughly cleaned.
 - 3. The hydrant shall be opened and closed as many times as may be necessary to determine if all parts are in proper working order, with valves seating properly and the drain valve operating freely.
 - 4. Care must be taken when handling hydrants to protect the paint. Whenever the paint is chipped or scratched, the Contractor shall repaint the hydrant.
- B. Hydrants shall be set so that at least the minimum pipe cover is provided over the branch supply line and the hydrant set within one inch (1") (25mm) of bury line at finished grade. All hydrants installed with an extension shall have the "traffic coupling"

adjusted to the proper height. All hydrants not buried or adjusted properly will be replaced or reset before final acceptance by the City at the Contractor's expense. Each hydrant shall be set on a concrete foundation at least eighteen-inches (18") (450mm) square and six-inches (6") (150mm) thick with No. 4 rebar at twelve inches (12") (300mm) on-center each-way (OCEW). Each hydrant shall be blocked against the end of the trench with a concrete thrust block, taking care to protect accessibility to bolts and to keep drainage holes open.

1. A 4'x4'x6-inch (1.2m x 1.2m x 150mm) thick concrete stabilizing pad with No. 4 rebar at twelve inches (12") (300mm) OCEW shall be cast around the hydrant barrel twelve inches (12") (300mm) below finished grade for all hydrants not constructed in concrete curbs or asphalt pavement, to ensure the hydrant breakoff feature. All concrete used shall be in accordance with the City of Casper Standard Specifications .
- C. Hydrant drainage shall be provided by installing gravel or crushed rock around the hydrant, and below the top of the hydrant supply pipe. One third (1/3) cubic yard (0.25m³) of one and one-half inch (1-1/2") (37.5mm) gravel is to be placed around drain holes just above hydrant valve casing. Gravel shall be placed a minimum of twelve-inches (12") (300mm) wide on all sides from the base of the hydrant to the point at least 6 inches (6") (150mm) above the drain hole. All hydrants shall stand plumb. Hydrants with pumper nozzles shall have hose nozzles parallel with, and the pumper nozzle perpendicular to the curb line and facing the curb. Parts of hydrants below ground shall be wrapped with polywrap taking care not to cover up drainage holes.
- D. Hydrants shall normally be set without the use of extensions. Extensions must be specifically authorized by the City before installation.
- E. All fire hydrant auxiliary valves and boxes shall meet the requirements of Section 501.04.D.
- F. Fire hydrant valves restrained to a PVC tee or a regular cast iron or ductile iron tee shall use a restraint harness for the fitting restrained with two stainless steel (Type 304) rods. All joint-restraining systems shall be cathodically protected in accordance to Division 500 Section 503 of these specifications.
- G. Cast iron or ductile iron tees with a swivel gland on the hydrant lead may also be used for fire hydrant connections. The fittings shall meet the requirements of Division 500 Section 501.04.B. The fire hydrant valve may be mechanical joint by mechanical joint or mechanical joint by push-on for use with the swivel fitting.

- H. Protection posts for fire hydrants shall be six-inch (6") (150mm) diameter, Schedule 40 steel, and shall be six feet (6') (1.8m) in length. The four posts shall be set three feet (3') (1m) into the ground in a twelve-inch (12") (300mm) diameter hole filled with concrete grout. The top three inches (3") (75mm) of the post shall be poured with concrete and rounded at the top so that water will run off; the remainder of the pipe shall be filled with concrete or sand (compacted in place by means of a steel rod). Posts shall be sandblasted "near white" (SPCC-SP10) and then painted with primer and enamel paint. Post shall be painted safety yellow. Each post shall have two rings of three inch (3") (75mm) white "light-reflective safety tape" attached to it. Tape shall be "all weather outdoor type". Guard posts, if required, shall be set a minimum three feet (3') (910mm) from the center operating nut and shall not obstruct the hydrant nozzles.

- I. Minimum setback shall be 24" back of sidewalk curb and gutter; 36" back of curb and gutter for parkways; and 36" back of curb and gutter where no sidewalk is installed. All fire hydrants shall be setback a minimum of 12" past corner radius. Hydrants shall not be placed within three feet (3') (910mm) of any other fixed object such as light poles, and telephone, cable television, or electrical pedestals. Fire hydrants shall not be placed on the same lot lines or corners as electrical transformers.

502.04 Standard Detail Section.

502/1 Standard Fire Hydrant Installation Detail

DIVISION 500

SECTION 503

CORROSION PROTECTION

503.01 Description.

The work covered by this section consists of furnishing all equipment, labor and materials necessary for proper corrosion protection to protect all buried metallic piping and fittings.

503.02 General.

- A. All metallic pipe, fittings, valves, hydrants, and other appurtenances shall be protected from corrosion by providing coatings and cathodic protection using pipe joint bonds, cross bonds, insulating joints, galvanic anode installation, and test stations as provided in Section 503.04 General Corrosion Protection Requirements.
 - 1. Submit a plan showing corrosion protection provisions to the Engineer for approval prior to start of work.
- B. Scheduling of the installation of the various corrosion control components should be arranged to coincide with other construction or replacement phases of the general project so that the items can be completed in the most efficient and expedient manner.
- C. Typical installations are shown in Drawings 503/1 through 503/10 of this section.

503.03 Materials.

A. Galvanic Anodes

- 1. The number and size of the galvanic anode(s) required for fittings, valves, tees, couplings, fire hydrants, and pipelines shall be as shown on the drawings, specified herein or as required by Engineer. Galvanic anodes will not be required for low soil corrosivity areas (resistivities over 5,000 ohm-cm.) Magnesium anodes shall be used in medium soil corrosivity areas (resistivities over 1,500 ohm-cm, but below 5,000 ohm-cm.) Zinc anodes shall be used in high soil corrosivity areas (resistivities less than 1,500 ohm-cm.)

B. Zinc Anodes

- 1. Zinc anodes (for soil resistivities below 1,500 ohm-cm) shall be made of zinc conforming to ASTM B-418 Type II. The zinc ingot shall be cast around manufacturer's standard steel core. The zinc anode size and weight may differ slightly because of variations in casting and mold shapes, but should be the manufacturer's standard and should approximate the following:

ZINC ANODE				
Bare Anode Weight (Lb)	Bare Anode (In)	Packaged Anode Weight (Lb)	Packaged Anode (In)	
			Diameter	Length
12	1.5 x 1.5 x 24	48	5	30
18	1.5 x 1.5 x 36	70	5	42
30	2 x 2 x 30	70	5	36

C. Magnesium Anodes.

1. Magnesium anode (for soil resistivities between 1,500 and 5,000 ohm-cm) shall be made of magnesium conforming to ASTM B-80 AZ 63C. The magnesium ingot shall be cast around manufacturer's standard steel core. The magnesium anode size and weight may differ slightly because of variations in casting mold shapes, but should be manufacturer's standard and should approximate the following:

MAGNESIUM ANODE				
Bare Anode Weight (Lb)	Bare Anode (In)	Packaged Anode Weight (Lb)	Packaged Anode (In)	
			Diameter	Length
9	3 x 3 x 13.5	24	6	17
17	4 x 4 x 17	42	6.5	19
32	5 x 5 x 21	70	8	30

D. Galvanic Anode Backfill

1. The galvanic anodes, either zinc or magnesium, shall be packaged in a permeable cloth bag or cardboard chip-type tube containing a backfill mixture of the following chemical composition:

Ground Hydrated Gypsum	75 Percent
Powdered Bentonite	20 Percent
Anhydrous Sodium Sulfate	5 Percent

2. Backfill shall have a grain size so that 100 percent is capable of passing through a 20-mesh screen and 50 percent will be retained by a 100-mesh screen. The backfill mixture shall be thoroughly mixed and firmly packaged around the galvanic anode within the cloth bag or cardboard tube by means of adequate vibration. The packaged anode shall weigh a minimum of 2.0 times the weight of the anode alone. Backfill material shall be of sufficient quantity to cover all parts of the anode to a minimum thickness of one inch (1") (25mm).

3. Anodes packaged in cloth bags shall be protected in a plastic or heavy paper bag of sufficient mil thickness to permit normal handling and shipping without tearing. Cardboard tubes shall have devices to hold the anode in the center of the tube.

E. Iron Pipe Anodes

1. Iron pipe anodes for copper services shall be six-inch (6") (150mm) minimum diameter ductile or cast iron pipe, ten-foot (10') (3.05m) minimum length. Iron pipe anodes shall consist of iron water mains abandoned in place during replacement or uncoated scrap iron pipe recovered from other water main replacements. Water mains abandoned in place used as iron pipe anodes may be left with the polyethylene wrap in place as long as the wrap is torn. No special backfill is required.

F. Wires

1. No. 2 AWG wire for pipe joint bonding, No. 8 AWG wire for insulator, fitting bonding, and copper service line bonding with iron pipe anodes, and No. 12 AWG wire for test station and galvanic anode leads shall be single-conductor, stranded copper with 600-volt TW or better thermoplastic insulation. Wire insulation color shall indicate the function of each test station wire and shall be as follows:
 - Anodes – Black
 - Pipeline or Fitting Test Wires – Blue
 - Foreign Pipelines – White or as requested by Foreign Pipeline Owner

G. Thermite Weld Materials

1. The electrical connection of copper wire to ductile iron and cast iron fittings and pipe shall be by the Thermite weld method. Thermite weld materials shall consist of wire sleeves, welders, and weld metal according to manufacturer's recommendations for each pipe type and diameter and wire size. The following table is included only as a guide:

DUCTILE IRON PIPE AND GRAY IRON OR DUCTILE IRON FITTINGS						
Wire Size ^a	Thermoweld			Cadweld		
	Welder	Sleeve	Cartridge	Welder	Sleeve	Cartridge
No. 12	HBA-1G-P.S. ^b	A200	25 pci	CAHBA-1G-P.S. ^b	CA-133-1H	CA32XF-19
No. 8	HBA-1G-P.S.	--	25 pci	CAHBA-1G-P.S.	--	CA32XF-19
No. 2	HBA-1V-P.S.	--	45 pci	CAHBA-1V-P.S.	--	CA45XF-19

^a Welders and sleeves given are for stranded AWG wire.

^b P.S. = Pipe or fitting size

2. Either pre-made factory-sleeved joint bonds or bond wires made in the field using the appropriate sized sleeves and a hammer die are acceptable. Weld materials for cast

iron fittings can be used on steel pipe, but weld materials for steel pipe cannot be used on cast iron fittings. Weld materials from different manufacturers should not be interchanged. The ceramic "one-shot" molds should not be used.

H. Thermite Weld Coatings

1. Coating materials for thermite welds shall consist of a pre-made thermite weld cap with coating, such as the Handy Cap by Royston (or approved equal). Royston Primer 747 should be used with the Handy Cap.

I. Cathodic Protection Test Stations

1. Test stations shall be flush-to-ground installed and suitable for heavy traffic-bearing loads. The test station shall be a Cott "Flush Fink", "Handley" test station or equal. The test station shall include a five-terminal plastic or glass-reinforced one fourth-inch (1/4") (6mm) thick laminate terminal block. Terminal studs and nuts are to be nickel-plated brass. The marker tags are to be aluminum or brass-embossed I.D. tags. Test stations with anodes shall be provided with a 0.01 ohm resistance Holloway Type R.S. shunt (or equal). The shunt shall be used to bond galvanic anode lead wire terminal to one of the pipe or fitting test station lead wire terminals.
2. The test station shall be placed in a cast iron valve box, five and one fourth inches (5 1/4") (130mm) in diameter, with locking lid (Tyler 6850 Series 461-S or equal). In paved roads, place asphalt around test station valve box. In gravel or unpaved roads, the test station with valve box shall be kept four to six inches (4"-6") (100mm-150mm) below the road surface. Where test stations are installed in undeveloped areas or behind curbwalk or curb and gutter, a concrete collar shall be provided to prevent breakage.
3. Test stations shall have a minimum of two wires to pipe or fittings (Drawings C2 and C6). Test stations shall be installed at all buried insulators (Drawing C7). Test stations at insulators shall include one No.12 test lead and one bond lead of No. 8 AWG wire to allow above grade testing of and bonding around buried insulator as required.

J. Wire Connections and Splices

1. A crimp-on, one-piece copper, tin-plated lug shall be installed on the end of the test lead (if the test lead is stranded wire) before connecting it to the test station terminal stud. Acceptable wire connections are manufactured by the Burndy Co., Thomas and Betts, or approved equal.
2. At test stations with anodes, shunts shall be magnesium wire shunt with 6-ampere capacity, 0.01 ohm Holloway Type RS (or approved equal).
3. After connecting the test and galvanic anode leads to the test station terminals, the metallic ends should be sealed to protect against moisture and corrosion. An

acceptable electrical sealer is Ivy-spray Type Scotch 1603, manufactured by the 3M Company or approved equal.

4. 3m dbr direct bury splice kits, suitable for 30 volts, or equivalent, shall be used for all wires being spliced.
5. Splice insulation and tape shall consist of spirally wrapping (with 50% overlap) a minimum of two layers of Scotch No. 130C linerless rubber splicing high voltage tape and two layers of Scotch No. 88 vinyl electrical tape suitable for wet environments as manufactured by 3M Products or approved equal.

K. Joint Bonds

1. Electrical continuity shall be provided for ductile iron pipe and fittings by electrically bonding all buried pipe joints and fittings. Bronze wedges are not an acceptable method of achieving electrical continuity. Joint bonds shall be No. 2 AWG single-conductor, stranded copper wire, with 600-volt TW insulation (Drawing C10). The joint bond shall be eighteen inches (18") (450mm) long and shall be supplied complete with a formed copper sleeve on each end of the bond wire.
2. Mechanical joint glands shall be bonded to valves, hydrants, or fittings using No. 8 AWG single-conductor, stranded copper wire, with 600-volt TW insulation. The gland bond shall be eighteen inches (18") (450mm) long and shall be supplied complete with a formed copper sleeve on each end of the bond wire.
3. Completed joint bond shall be tested before coating and backfilling.
4. Bonds shall be suitably coated to prevent corrosion of the pipe, bond, and connection.

L. Flange Insulating Kit

1. Flange insulating kit (Drawing C10) shall consist of a full-face, Type E gasket and, for each bolt, two insulating washers, two steel washers, and one full-length phenolic or fiberglass reinforced epoxy insulating sleeve with washers. The complete assembly shall have an ANSI rating equal to that of the flange. The flange gasket shall be supplemented with a neoprene facing on each side and molded half O-rings in grooves on opposite sides of the insulating retainer to accomplish a seal. Acceptable insulators are manufactured by Pacific Seal, Inc., Burbank, California or approved equal.
2. The flanges must be checked to ensure that they do not have any sharp edges before installing the full-face gasket. Install the steel washer, the insulating washer, and then the insulating sleeve on the bolt before putting it in the flange. Make sure that the

insulating sleeve is not too long or it will break when the bolt is tightened. The maximum length should be slightly less than the thickness of the two flanges and the gasket combined. For buried insulators, install the single insulated washer so that the bolt and nut are electrically connected into the cathodic protected side of the insulator. Buried insulators should be both coated and tape wrapped. After assembly, test the insulator both prior to coating and after backfilling is completed.

M. Service Line Insulator

1. The service line insulator should be a standard brass female-to-male fitting with a nylon dielectric bushing between. Its working pressure should be equal to or higher than the system on which it is to be installed. An acceptable service insulator is an H-10-871, as manufactured by the Ford Meter Box Co. Inc., or equal. Take care to ensure that the insulator is correctly aligned during installation.

N. Insulating Barrier

1. At locations where spacing between cathodically protected water system piping is installed within six inches (6") (150mm) of a foreign metal structure, pipeline, reinforcing, or grounding system, an electrical insulating material such as a plastic, rubber, or a one-fourth inch (1/4") (6mm) thick micarta or rubber sheet twelve inches (12") (300mm) wider than the pipeline shall be installed between the structure and the water piping to prevent electrical shorting. The insulating material shall be of sufficient size to provide a minimum twelve-inches (12") (300mm) electrical separation at all points.

O. Bolts, Nuts, Washers

1. All bolts, nuts, and washers installed below grade in all areas shall be Series 300 stainless steel. Bolts shall be tee-headed (Type 304 SS). Nuts shall be semi-finished heavy hex head ASTM A194 (Type 304 SS). Stainless steel washers (Type 304 SS) shall be used.

P. Cement

1. All cement for buried applications shall be Type V Portland cement or modified Type II with equal sulfate resistance characteristics.

Q. Ground Clamps

1. Ground clamps for wire connection to copper service pipe shall be sized to fit the pipe and wire. All parts of the clamp shall be bronze, except the bolts and nuts which shall be stainless steel, as manufactured by O.Z. Gedney, Thomas and Betts, or equal.

R. Shop-Applied Coating

1. All buried exterior and interior surfaces of all new ferrous metallic construction materials (fittings, fire hydrants, shoes, valves, tees, mechanical joint glands, etc.) shall be coated with liquid epoxy or fusion-bonded epoxy coating conforming to AWWA C116 or C550 as appropriate. All internal coatings shall be NSF approved for potable water service. The interior of the fitting shall be finished with a cement mortar lining conforming to AWWA C104.

The coating thickness shall be applied per the applicable AWWA standard. The coating shall be continuous, smooth and without visual defects.

S. Field Coatings

1. Field exterior coating selection should be tailored to meet individual application requirements, surface conditions, and anticipated exposure. Coating manufacturer's written recommendations should be followed for product selection, surface preparation, compatibility with factory coating, application, and repair procedures based on anticipated exposure. Primer and cover coats from different manufactures shall not be intermixed. Buried fittings, pipes, or appurtenances not factory-coated shall be coated with the following coatings and general guidelines:
 - i. The fitting or pipe surface shall be cleaned by wire brush or sandblasting to remove all rust, mill scale, weld splatter, grease, dirt, dust, oil, and any other foreign matter. The surface shall be smooth and completely clean and dry prior to application of coating.
 - ii. Heat-shrink-to-fit sleeves meeting AWWA C-216, as manufactured by Raychem, Tapecoat, or approved equal are to be used only for field-coating clean, smooth fittings and pipe sections where the absence of sharp angles, edges, and bolts allow a tight bond to the pipe or fittings.
 - iii. Heat-applied asphalt can be applied to wire or bond connections on top of the pipe or fittings. Do not apply to the bottom of fittings or pipe.

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- iv. Cold-applied tape coating, meeting AWWA C-209, shall consist of a suitable field primer and minimum 35-mil thick patch/repair/joint tape with aggressive adhesive and release liner four or six inches (4" or 6") (10mm or 15mm) wide. The tape shall be applied in spiral wrap with a 50 percent overlap. Acceptable cold-applied tap coatings are Tapecoat H35 Gray by Tapecoat, Polyken 1027 primer with Polyken 934-35 tape by Tyco, or approved equal.
- v. Water- or air-cured 100% epoxy coating can be applied to fittings and joint restraint systems that have angles, sharp edges, bolts, and nuts. It can also be applied to the bottom of pipes and fittings. Acceptable epoxy coatings are Aquata Poxy by Raven, A-788 Splash Zone Compound by Koppers, or approved equal. The epoxy coating can be applied by brush in a layer 20-mil minimum thickness. The epoxy coating should overlap existing coating by two inches (2") (50mm) minimum. Do not backfill for six to eight hours after coating application to avoid damage to uncured epoxy coating. The coating shall then be protected from backfilling by using polyethylene encasement
- vi. Mastic can be used to coat corporation stop and service saddles connected to non-metallic mains, ground clamps connected to copper service pipe, and stainless steel rods and harnesses, etc. The mastic shall be a corrosion resistant, waterproofing mastic installed in accordance with manufacturer's instructions and recommendations. Acceptable mastics are Polyken Solid Mastic No. 937 by Tyco, Roskote A51 by Royston or approved equal. The coating shall be protected from trench backfilling damage by using polyethylene encasement.

T. Polyethylene Encasement

- 1. Polyethylene encasement material (poly-tube) shall conform to the requirements of AWWA C105 for tube type installation and shall have 8-mil nominal film thickness. The wrapping tape shall be Scotchrap No. 50 (polyvinyl) or equal and be 10 mils thick.

503.04 General Corrosion Protection Requirements

A. Low Corrosivity Areas (Soil resistivity greater than 5000 ohm-cm)

- 1. The buried exterior and interior surfaces of all new ferrous metallic construction materials (fittings, fire hydrants, valves, tees, mechanical joint glands, joint restraint systems, etc.) shall be coated in accordance to Division 500 Section 503R or S with coatings as applicable.
- 2. Polyethylene wrap shall be required on all ductile iron pipe and fittings. Wrap shall be required on all fittings, valves, and fire hydrants used in conjunction with either PVC or ductile iron pipe.

3. The polyethylene wrap tubing shall be cut to provide for a minimum of one foot (1') (300mm) of lap over both the adjoining pipes. The ends of the tubing shall be wrapped using three (3) circumferential turns of plastic adhesive tape. The loose wrap on the barrel is to be pulled snugly around the barrel of the pipe and the excess folded over at the top. This fold will be held in place by means of six-inch (6") (150mm) strips of the plastic tape placed at intervals of three feet (3') (900mm) along the pipe barrel. Bends, reducers, and offsets shall be wrapped in the same manner as pipe. Any damaged areas of the polyethylene wrap shall be repaired before backfilling.
4. Valves shall be wrapped by bringing the tube wrap on the adjacent pipe over the bells of the valve and sealing with adhesive tape. The valve bodies are then wrapped up around the body to the stem and fastened with the tape. Hydrants shall be similarly wrapped for all portions below the ground line. Any wrap damaged in placing the pipe shall be properly repaired.
5. The polyethylene encasement at service line connections may be directly drilled through by the tapping machine. Following tap installation, polyethylene wrap shall be pulled tightly around the corporation stop and securely taped. All damage to the wrap caused by the tapping machine shall be repaired.
6. Copper service lines do not need corrosion protection in low corrosivity areas. Anodes are not needed in low corrosivity areas to protect fittings, valves, hydrants, or ductile iron pipe. Ductile iron pipe, valves, fittings, and mechanical joint glands do not need to be bonded together.
7. All service saddles and corporation stops connected to non-metallic mains shall be coated with in accordance to Division 500 Section 503.S.1 of these specifications.

B. Medium to High Soil Corrosivity Areas (Soil resistivity less than 5,000 ohm-cm)

1. The buried exterior and interior surfaces of all new ferrous metallic construction materials (fittings, fire hydrants, valves, tees, mechanical joint glands, joint restraint systems, etc.) shall be coated in accordance to Division 500 Section 503R or S as applicable.
2. Ductile iron pipe shall be bonded at all joints and fittings. Hydrant valves shall be bonded to the swivel tees. Fire hydrant barrels shall be bonded to the shoes. The bonds shall be No. 2 AWG wires. Wire bond lengths to and around fittings shall be formed in the field so as to have two inches (2") (50mm) of slack after connections.
3. All mechanical joint glands at valves, hydrants, or fittings shall be bonded to the main body using #8 AWG wires. Wire bond lengths to and around the glands and fittings shall be formed in the field so as to have two inches (2") (50mm) of slack after connections.

4. In addition to the above bonding requirements and polyethylene encasement requirements as detailed in Section 503.06.A above, all ductile iron pipe, fittings, fire hydrants, and valves shall be cathodically protected using magnesium or zinc anodes depending upon the soil corrosivity. The type, size, number, and location of those anodes shall be indicated on the plans or in an addendum to these specifications.
5. Where PVC pipe is used on fittings without test stations, the galvanic anode lead wire shall be connected directly to the fitting.
6. Corrosion monitoring test stations shall be installed at several locations as determined by the Engineer. The test stations shall be provided with two No. 8 AWG wires thermite welded to the pipe, fitting, hydrant shoe, or valve, no less than twelve inches (12") (300mm) apart. The anode lead wire shall be connected to the terminal board in the test station with a crimp-on lug terminal connector.
7. The test station lead wires shall be buried in a trench no less than two feet (2') (600mm) deep. The lead wires shall have at least eighteen inches (18") (450mm) of slack in the trench. All wire splices shall use a compression connector or a twisted and soldered connection. All splices shall be made using scotch cast splice kits or approved equal. No spliced wires will be allowed underground. At least two feet (2') (600mm) of coiled up lead wire shall be in each test station. Each lead wire in each test station shall be provided with an identification marker and compression terminal connectors. All test stations shall be provided with a shunt to connect the galvanic anode lead wire terminal to one of the No. 8 test station lead wire terminals.
8. Test stations on ductile iron pipe shall be placed behind the curbwalk or curb and gutter for anode strings and in the street over the pipeline for anodes connected individually to the pipeline. Test stations on PVC pipe appurtenances shall be placed in the street over the fitting or valve or behind the curbwalk or curb and gutter near the hydrant shoe.
9. When PVC water main pipe is used, the copper service lines shall be bonded to an 8 to 10 foot (8'-10') (2.5 – 3m) section of old abandoned or used four-inch (4") (100mm) or larger ductile iron or cast iron pipe using No. 8 AWG wire and a ground clamp on the copper pipe. All compression couplings on copper pipe need jumper wires. As an alternate, galvanic anodes may be used also connected to the copper service line by a ground clamp. The type and size of these anodes shall be indicated on the plans or in an addendum to these specifications. The ground clamp shall be coated in accordance to Division 500 Section 503.03.S.1. of these specifications.
10. All service saddles and corporation stops connected to non-metallic mains shall be coated with in accordance to Division 500 Section 503.S.1 of these specifications.
11. All metallic material (except copper service lines) must be wrapped in polyethylene encasement after all coatings, bonds, and corrosion control is installed on the pipe and fittings, etc.

503.05 Installation

A. Galvanic Anodes

1. The quality of workmanship for the installation of the galvanic anodes shall be of the highest grade and shall be in strict accordance with the material manufacturer's instruction. Equipment or material damaged during shipment, storage, or in the course of installation shall be replaced. Figures C1 through C8 indicate the general arrangement of the anodes and test stations, etc.
2. All prepackaged galvanic anodes shall be stored off the ground and kept dry at all times. Anodes shall be protected against weather, condensation, and mechanical damage. All damaged pre-packaged anodes shall be removed from the job site. Pre-packaged anodes shall be handled with care to prevent anode breakage or loss of backfill material. Anodes shall not be lifted, lowered, or held by the lead wire.
3. Anodes shall be installed one foot below the pipe invert, alternating anode placement on opposite sides of pipe. Galvanic anodes shall be spaced equally around the pipeline or appurtenance and shall be located a minimum of two feet (2') (600mm) for zinc and three feet (3') (900mm) for magnesium from the metallic fittings at the bottom edge of the trench. Maximum anode spacing from fitting or pipeline shall be five feet (5') (1.5m).
 - i. Galvanic anode strings shall consist of no more than five anodes for zinc and ten for magnesium. Anodes shall be spaced twenty feet (20') (6.1m) minimum from the pipeline with ten feet (10') (3.05m) on-centers. The anode string header cable shall be terminated in a test station with a shunt to monitor the anode string current output and pipe potential.
 - ii. Anodes may be installed vertically or horizontally. A minimum anode spacing of two feet (2') (600mm) from other unprotected pipelines should be provided. Augered holes for vertical anodes shall be the width of the anode plus six inches (6") (150mm) to allow thorough soil compaction around all sides of the anode to the specified depth. Augering equipment shall be suitable for soil conditions, with capabilities for augering to a depth equal to 1.2 times the specified anode installation depth.
 - iii. Anodes shall be installed after augering or trenching is completed. Remove the plastic or outer paper covering, if present on the anode, but leave the cloth or cardboard intact prior to installation of the anode. Anodes packaged in cardboard type chip-tubes shall be thoroughly perforated just prior to installation. Pre-packaged galvanic anodes shall be placed in the center of the augered hole or at the edge of the pipe trench, and the earth backfill thoroughly compacted around the anode in six inches (6") (150mm) lifts to a point one foot (1') (300mm) above the anode. Earth backfill material around

each anode shall be native soil free of roots, organic matter, trash, and rocks. If sand backfill is used for pipe installation, cover anodes with one foot (1') (300mm) of native material before placing sand. Stop backfill at specified grade to allow for placing of topsoil or pavement, when required.

- iv. All anode wires shall be buried a minimum of twenty-four inches (24") (600mm) below finish grade. Wires shall be handled with care. Splices or damage to the insulation on any wire shall be wrapped with two layers of Scotch No. 130C linerless rubber splicing high voltage tape and two layers of Scotch No. 88 vinyl electrical tape. Wire splices shall be made with 3m dbv/dbr direct bury splice kits, suitable for 30 volts, or equivalent.
- v. Galvanic anode connections to cast iron or ductile iron fittings, appurtenances, and pipe shall be made by the thermite weld method. The anode wire shall be wrapped once around the water main so that the wire can be attached to the top of the fitting or pipe. Any damage to the pipe or fitting interior coating shall be repaired in accordance with the coating manufacturer's recommendations.

B. Wire Connections

1. All wire connections and joint bond installations depend on the quality of workmanship in obtaining a good electrical connection. Proper adhesion of the welded connection is dependent on the pipe surface preparation. It also depends on the proper cartridge, welding, and soldering techniques being used for the wire, and on the pipe size and type to be welded. Assure that the pipe or fitting material is of sufficient thickness that the thermite weld process will not damage the pipe or fitting integrity.
2. The electrical connection of copper wire to ductile or cast iron pipe and ductile iron or cast iron fittings shall be by the thermite weld method. Before making the connection, the surface must be cleaned to bare metal by making a two-inch x two-inch (2" x 2") (50mm x 50mm) window in the coating and then filing or grinding the surface to produce a bright metal finish. The base metal and wire must be free of moisture for a successful connection. Place the wire on the bright metal area with the welder on the wire. A steel disc and cartridge should be placed in the welder before placing it over the wire. Wear leather gloves, protective eyewear, and ignite the powder with the flint gun striker. Hold the welder steady during ignition and do not breathe the smoke from the weld. Do not allow either hot slag or welder to contact PVC pipe or pipe coatings. Do not remove the welder from the weld until it has partially cooled (approximately 20 to 30 seconds). After cooling, the connection should be lightly tapped several times with a hammer to remove slag and check for a sound connection. Wipe it with a dry cloth. Coat all finished thermite welds and cleaned pipe surface with a light coat of coal tar mastic primer. After the primer dries to a non-glossy appearance, remove the release from the thermite weld cap and press the cap firmly into place over the thermite weld. Damage to the coating not covered by thermite weld cap is to be repaired with cold-

applied tape, asphalt, 100 percent epoxy coating, or approved mastic as described in Division 500 Section 503.S.1. of these specifications. Use care when placing the first backfill to prevent damage to wires. Clean welder mold after each ignition to prevent contamination of the next weld.

3. The locations and type of the cathodic protection test stations shall be as indicated by Engineer or on drawings. Typical test stations are shown in Figures C2, C6, C7, and C8. Each test station shall be located directly over the pipe or fitting where possible, or located to the side of the street in areas of heavy traffic flow. The wires from the test stations shall be buried a minimum of twenty-four inches (24”) (600mm) below finished grade in order to prevent damage. The test wires shall be looped to prevent the wire from being unduly stressed or broken during backfilling operations. Maintain sufficient slack so the test station and wires can extend eighteen inches (18”) (450mm) out of the test valve box. Wires with less than twenty-four inches (24”) (600mm) of ground cover shall be installed in rigid conduit.
 - i. Wire connections to test station terminals shall be with crimp-on, lug terminals. After the lugs are connected to the terminal stud and are checked for continuity, they shall be coated with an electrical grade sealer. The sealer is a spray-type coating and shall be used every time the station is used for testing. The wire shall be tested for continuity both before and after backfilling has been completed. This testing can be accomplished by measuring the pipe-to-soil potential. Test wire labeling, with embossed-metal tags, shall be maintained for each test station installed. The pipeline identification letters on the metal tags shall be as shown in the following table. (For example, a fire hydrant protected by a 30-pound zinc anode would be labeled FH for the two fire hydrant test leads and 30/ZN for the anode test lead.)

Identification Letters	Size/Type of Anode or Pipe/Fitting
--	Anode Size in Pounds
ZN	Anode Type Zinc
MG	Anode Type Magnesium
PA	Pipe Anode
ML	Mainline
S	Service Line
T	Tee
V	Valve
FH	Fire Hydrant Stub/Ell

LRC	Leak Repair Clamp
Y	Wyes
X	Crosses
C	Couplings

C. Electrical Isolation

1. Ductile or cast iron pipe shall be insulated from steel pipelines. The coating shall be continuous, smooth and without visual defects in accordance with the manufacturer's recommendations. Test stations with one No. 8 AWG and one No. 12 AWG test leads shall be installed to either side of the buried flange insulator. The test stations are required to allow testing and above grade bonding, if required of the insulator.
2. Copper service lines shall be insulated on the City side of the curb stop. Copper service lines shall be electrically insulated on each side of the insulator for three feet (3') (900mm) by wrapping the copper pipe with cold-applied tape coating or approved equal.

503.06 Testing

A. Galvanic Anode Testing

1. After installation of the galvanic anode is completed, connect the anodes to the appropriate pipe, fitting, or appurtenance test leads in the test station. Record the location, date, size, and number of anodes installed on the proper galvanic anode forms furnished by City. Measure the anode-to-soil and structure-to-soil potentials and anode current output. Sketch a record drawing of the anode and wire lead installation. Provide the above information on and with the record "As-Built" drawings.

B. Joint Bond Testing

1. The completed joint bond shall be tested before being coated and backfilled. The Contractor, at his sole expense, shall replace or install an additional joint bond on any joint with a resistance greater than 0.000325 ohm for an eighteen-inch (18") (450mm) long No. 2 AWG copper joint bond wire until the resistance is within the specified allowance. The Contractor shall protect the completed joint bonds during the backfilling operation. Any damaged joint bonds or pipeline electrical discontinuity discovered during testing prior to or following pipe backfilling shall be repaired by the Contractor. The Contractor shall locate, uncover, and repair any defective bonds at his sole expense.

- i. Testing of joint bonds shall be conducted by either the Engineer or Contractor, depending on the particular project construction requirements. The joint bond resistance is measured by contacting the pipe on each side of the joint, (for example, from one pipe bell to the next pipe spigot.) Test leads should be in firm contact with a cleaned, bright metal spot on the pipe. Test lead connections to bond wire, bonding studs, or thermite welds are not acceptable.
- ii. Test records of the joint bond testing should include: (a) stationing of the joint tested, (b) date of test/person who conducted the test, (c) bond type, and (d) joint resistance.

C. Coating Inspection

1. Factory-applied coatings shall be protected from damage by using nonmetallic or padded packing, slings, and straps during shipment and installation. Coating finish shall be pinhole free and inspected after cure for continuity using a holiday detector in accordance with the manufacturer's recommendations. Dry film measurements shall also be taken. All voids, cracks, and damaged areas shall be repaired following manufacturer's recommended procedures. Material for damaged or uncoated areas shall be compatible with the original coating and shall be supplied by the coating manufacturer. Significantly damaged material may be rejected at the Engineer's discretion. For coated items, evidence of excessive exposure to weather, such as checking, spalling, or brittleness of the coating, will be grounds for rejection.

503.07 Standard Detail Section.

503/1 Typical Galvanic Anode Installation at Iron Fittings on PVC Watermains Detail

503/2 Typical Galvanic Anode and Test Station Installation on PVC Watermains Detail

503/3 Ductile or Cast Iron Pipe Anode Detail

503/4 Galvanic Anode Installation Detail

503/5 Galvanic Anode String Installation Detail

503/6 Typical Test Station Installation Detail

503/7 Test Station for Insulated Joint Detail

503/8 Test Station for Foreign Pipeline Detail

503/9 Typical Joint Bond Detail

503/10 Insulating Flange Detail

DIVISION 600

SECTION 601

SANITARY SEWERAGE COLLECTION FACILITIES

601.01 Description

- A. This Section covers the furnishing and installation of all materials, labor, tools, and equipment to construct complete, in-place sanitary sewer mains, sewer service lines, and all appurtenances in accordance with the requirements of the Contract Documents, and as specified herein. The Contractor shall also do the excavating of all kinds of materials encountered, furnish or compact foundations where required, furnish and install all timbering, sheeting and bracing necessary or proper to safely support all work, remove all water, protect, repair, relocate, maintain, and restore all subsurface, surface, and overhead structures directly or indirectly disturbed, injured, or affected by his operations, and furnish all other appurtenant items and services necessary or specified.

601.02 Materials

- A. The materials used in this work shall all be new and conform to the requirements for class, kind, size, and material as specified herein.
1. A copy of the manufacturer's installation recommendations for each kind of pipe used must be provided to each foreman and inspector prior to construction and must be followed during construction unless otherwise instructed.
 2. When required by the Engineer, the Contractor shall furnish certification by the manufacturer of the pipe to be furnished on this project, certifying that the pipe and fittings comply with the applicable specifications.
 3. All pipe shall be clearly marked with type, class, and/or thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.
 4. Except in locations where the soils are contaminated by hydrocarbons and other locations designated by the City, all sewer main piping shall be polyvinyl chloride pipe (PVC).
 5. Sewer main pipe installed in soils contaminated with hydrocarbons shall be ductile iron with "nitrile" gaskets and double polywrapped. Water main fittings, fire hydrants, and valves, etc., installed in soils contaminated with

hydrocarbons shall be ductile or cast iron, with “nitrile” gaskets, and double polywrapped.

6. All metallic pipe shall be bonded and protected from corrosion by coatings, sacrificial anodes, and/or other means appropriate to the location and approved by the Engineer (See Division 500 Section 503 of these specifications.)

B. Polyvinyl Chloride Pipe (PVC) and Fittings

1. PVC pipe and fittings shall conform to ASTM D-3034, SDR 35 (4-inch through 15-inch) (100mm – 375 mm) or ASTM F679, Type I, SDR 35 (18-inch through 27-inch) (450mm – 675mm). Each joint of pipe shall be marked with the size, SDR, “Sewer Pipe”, and code number. The pipe and fittings shall have bell and spigot joints with approved gaskets. The spigot end shall be marked so that the installer and the inspector can determine when the pipe is properly installed.

C. Ductile Iron Pipe (DIP)

1. Ductile iron pipe shall conform to the requirements of AWWA C151, laying condition type 5 with “Buna-n-Nitrile” gaskets, except the minimum design thickness shall be pressure Class 350.
2. All joints shall be push on joints complying with AWWA C111.
3. The interior of the pipe shall be epoxy lined or polyurethane lined to a nominal thickness of 40 mils in general conformance to AWWA C-210, C-213, or C-550. The bell gasket area and the spigot ends shall have a nominal interior thickness of 6 mils in order to alleviate assembly problems. The pipe exterior shall be a tar or bituminous seal coating at least one mil thick. The coating shall adhere to the pipe and spotty or thin coating, or poor adhesion, shall be cause for rejection of the pipe.
4. All metallic pipe shall be bonded and protected from corrosion by coatings, sacrificial anodes, and/or other means appropriate to the location and approved by the Engineer. (See Division 500 Section 503 of these specifications)

D. Service Pipe Within the Public Right-of-Way

1. Service pipe materials may be extra heavy cast iron pipe, PVC sewer pipe (ASTM D2665 Schedule 40 or ASTM D3034, SDR 35) or ABS sewer pipe (ASTM D2661). An approved watertight commercial adapter joint shall be used to connect the service pipe to the sewer main wye or saddle adapter.

E. Reducing Wyes

1. Service connections to the main line shall be made with monolithic reducing wyes installed in the main line or if allowed by the City with approved saddle adapters. The reducing wye fittings shall meet ASTM D3034, SDR 35 (4-inch through 15-inch) (100mm – 375 mm) or ASTM F679, Type I, SDR 35 (18-inch through 27-inch) (450mm – 675mm).

F. Manholes

1. All manholes and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Manufacturer's certificates of compliance and installation recommendations shall be provided to the Engineer and City prior to construction.
2. All manholes shall be constructed with concentric precast concrete sections without steps unless otherwise approved. Precast concrete manhole sections shall be manufactured to standards at least equal to or greater than the requirements of the Standard Specifications for Precast Reinforced Concrete Manhole Sections, ASTM Designation C478. The minimum internal diameter for sanitary manholes shall be forty-eight inches (48") (1.2m) unless shown otherwise. Manholes shall conform to all requirements as shown on the detail drawings. Precast manhole joints shall be made water-tight with Ram-Nek material or an approved gasket at each joint. The Ram-Nek and primer must be used in accordance with the manufacturer's instructions. Rubber gaskets used for precast manhole joints shall be designed in accordance with ASTM C361, C478, C443, and AASHTO M 315-94. All lifting holes must be grouted in after placement. All cement for manholes and drop manhole encasement shall be Type V Portland cement or modified Type II with equal sulfate resistance characteristics.
3. The concrete base shall be cast-in-place or precast concrete of the size and depth shown on the drawings. Concrete used for bases shall have a twenty-eight (28) day compressive strength of at least four thousand pounds per square inch (4,000psi) (27,600 kPa). Approved precast concrete bases will be allowed if provided with an integral groove for barrel placement. Precast concrete bases shall conform to ASTM C478. Manholes with the base monolithically poured with the bottom barrel are also acceptable and preferred.
4. Precast manhole inverts shall be constructed using a secondary invert forming system designed to provide a finished invert that aligns precisely with the

incoming pipelines, incorporating a finished flow depth of 0.8 to 1.0 diameter of the largest pipe. The completed precast invert shall include an alignment bench for each pipe, and provide for uniform horizontal and vertical transition through the manhole in accordance with drawings. Provide 0.1' (30mm) minimum fall between inlet and outlet. After the installation of the pipelines into the manhole, the interior annular space around the outside of the pipe shall be sealed with grout. Manhole couplings or other acceptable water stops (i.e. PVC pipe gasket stretched over outside of pipe, Ram-Nek, etc.) must be used when connecting PVC pipe to manholes. The acceptable tolerances for manhole inverts are one-quarter inch (1/4") (6.25mm) in any dimension and within 2 degrees for alignment. The invert forming system shall be "A-Lok Tru Contour", or approved equal.

5. Manhole frames and covers shall be six-inch (6") (150mm) Neenah R 1726-A, or 1258, D&L Supply A-1040 or approved equal. Cover and frame seat shall be machine finished to prevent any rocking of cover in its associated frame. Cover shall have the word "sewer" clearly cast on its surface.
 - a. When required, self-sealing, waterproof frames and covers meeting Neenah R-1916-F or D&L Supply E-1926 or approved equal shall be used.
6. For manholes with depths of six feet (6') (1.8m) or less, all of the precast manhole sections shall be of the specified diameter and shall have a flat, precast concrete top.

G. Granular Materials

1. Granular materials furnished for foundation, bedding, encasement, or other purposes as may be specified, shall consist of any material or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone or slag, that shall be so graded as to meet the gradation requirements specified herein for each particular use (See Drawing 501/1.)
2. Granular Material Gradation Classifications
 - a. Granular materials furnished for use in Foundation, Bedding, or Encasement installations shall be:

MATERIAL USE DESIGNATION

<u>Percent Passing Sieve Size</u>	<u>Foundation</u>	<u>Bedding & Encasement</u>
1 inch (25mm)	100	
¾ inch (20mm)	85-100	90-100
3/8 inch (9.5mm)	30-60	50-100
No. 4 (4.75mm)	0-10	35-100
No. 200 (0.075mm)		0-15

- b. Other gradations may be used if written approval is obtained from the City Engineer.
- c. Other approved material for bedding and encasement shall consist of sand, sandy gravel, or fine gravel having a maximum size of three-quarter inch (3/4") (20mm), uniformly graded and a maximum plasticity of 6 as determined by AASHTO T-89 and T-90.
- d. Certified copies of all sieve analysis and plasticity analysis for the above materials shall be submitted to the City Engineer and approved before construction starts. Other sieve or plasticity analysis may be required during construction as directed by the City Engineer.

3. Granular Material Use Designations

- a. Granular materials provided for Foundation, Bedding, or Encasement use as required by the Contract, either as part of the pipe item work unit or as a separate Contract Item, shall be classified as to use in accordance with the following:

<u>Material Use Designation</u>	<u>Zone Designation</u>
Granular Foundation	Placed below and to the midpoint of the pipe as replacement for unsuitable or unstable soils, to achieve better foundation support.
Granular Bedding	Placed from four inches (4") (100mm) below the pipe to the pipe midpoint to facilitate proper shaping and achieve

uniform pipe support. When foundation material is required, the granular bedding shall be of foundation material gradation.

Granular Encasement

Placed below an elevation one foot (1') (300mm) above the top of pipe, after pipe installation, for protection of the pipe and to assure proper filling of voids or thorough consolidation of backfill

H. Select Backfill

1. Job excavated and imported select backfill material shall be free from debris, organic material, and stones larger than three inches (3") (75mm) in diameter. Contractor shall be responsible, at his expense, for separating debris, organic material and stones larger than three inches (3") (75mm) in diameter. Select material that the Engineer directs to be used shall be the same gradation as bedding and encasement material. No asphalt chunks or concrete may be used as select backfill.

I. Ground Water Barriers

1. Low permeability ground water barriers shall be used where directed. Barrier material shall meet soil classification GC, SC, or CL per the Unified Soil Classification System and shall have a liquid limit less than 50. The barrier material shall be compacted to 95 percent of maximum density. Job excavated material meeting one of the above soil classifications and free from stones, organic matter, and debris may be used.

601.03 Excavation and Preparation of Trench

- A. When cutting into existing roads, streets, alleys, or other public rights-of-way, the Contractor, shall obtain the proper licenses, cut permits, etc. from the appropriate authority.
- B. When trench excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a spadebitted air hammer, concrete saw, or similar approved equipment to obtain a straight,

square, clean break. Cuts shall be located at standard joint locations when possible.

- C. When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces the Contractor shall strip the cover material to full depth of the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose. New material shall be provided as necessary. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of twelve inches (12") (300mm), whichever is less.

- D. The disturbed area from construction shall be confined within the construction limits.
 - 1. The trench shall be dug only as far in advance of the pipeline as work can be reasonably completed that day. The sides of the trench shall be sloped and/or braced in accordance with the current OSHA Rules and Regulations and the trench drained so that workers can work safely and efficiently. All work must be done in a dry trench and no water will be permitted to discharge down the pipe previously laid. A sewer plug shall be installed at the connection to existing sewer system. Discharge of pumps shall be to approved natural drainage channels or storm sewers. Wyoming State Engineer groundwater permits and Department of Environmental Quality discharge permits shall be required for dewatering.

- E. Pipe crossings under sidewalks or curbs may be made by tunneling only if approved by the Engineer. If the Contractor elects to remove a portion of the sidewalk or curb, he must use a concrete saw for making neat joints corresponding to existing joints, compact the backfill as specified, and pour a new concrete sidewalk or curb section in accordance with the applicable sections of these specifications.

- F. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials shall be stored and retained at least two feet (2') (600mm) or more from the edge of the trench in accordance with Wyoming Occupational Health and Safety Rules and Regulations for Construction. Excavated material must not be piled over nearby existing parallel trench lines unless adequate precautions are taken by the Contractor to prevent sidewall failure. Ready access to existing fire alarm boxes, fire hydrants, valves, manholes, and other appurtenances must be maintained.
 - 1. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils, which cannot be properly compacted, and all other deleterious materials shall be

immediately removed from the construction site and properly disposed of in accordance with applicable laws.

- G. Surface drainage of adjoining areas shall be unobstructed. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in unbackfilled trenches until after the pipe has been placed, tested, and covered with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be reinstalled. Gutters shall be kept clear or other satisfactory provisions made for street drainage at all times.
- H. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings. Bedding material shall be added four inches (4") (100mm) minimum to provide uniform bearing and support for each section of pipe at every point along its barrel length with bell holes dug for bells. Care must be taken to avoid over excavation. Unauthorized over-depths shall be backfilled with approved bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to a minimum of 95% density as determined by ASTM D698. The finished trench bedding beneath the pipe shall be prepared accurately by means of hand tools.
1. The bottom of all excavations shall be neat and clean, and graded accurately to the line and grade shown on the drawings. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material by compacting soil material to at least 95% Standard Proctor, ASTM D698.
 2. If in its natural state the material at the bottom of the trench is soft and, in the opinion of the Engineer, cannot support the pipe, a further depth and/or width shall be excavated as directed by the Engineer and refilled with foundation material to the midpoint of the pipe. Other approved methods may be used to assure a firm foundation.
 3. Foundation material used to dewater the trench or to replace a wet material shall be considered incidental to construction.
- I. Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches (6") (150mm) below the outside barrel of pipe and allow a clear width of six inches (6") (150mm) on each side of the pipe. The space between the bottom of the trench in bedrock or rocky areas and the bottom of the pipe shall be backfilled with suitable granular material in three-inch (3") (75mm) uncompacted layers and thoroughly tamped before pipe is installed.

- J. Blasting the excavation to remove rock, clay, or hardpan will not proceed until the Contractor has notified the Engineer of the necessity to do so and obtained written approval. This notification shall in no manner relieve the Contractor of the hazard and liability contingent on blasting operations. The City Engineer shall fix the hours of blasting. The Contractor at his expense shall repair any damage caused by blasting. The Contractor's methods of procedure relative to blasting shall conform to local and state laws and municipal ordinances, and the necessary permits shall be obtained.
- K. All excavated material shall be piled within the construction limits or in a location obtained by the Contractor and accepted by the Engineer in a manner that will not endanger the work and that will avoid obstructing sidewalks, driveways, and fire hydrants.
- L. The width of the trench shall be such to provide adequate working room for workers to install the pipe in the specified manner. The trench in the pipe zone and to one foot (1') (300mm) above the pipe zone shall be adequate in width to allow for proper compaction but shall in no case be wider than the pipe diameter plus three feet (3') (900mm).
- M. Where the trench is not located near existing utilities, buildings or other structures, and where water and other conditions permit, the Contractor may omit sheeting and bracing of the excavation. In this event, sides of the trench if in unstable or soft material or five feet (5') (1.5m) or more in depth, shall be sloped to protect the workers working within them in accordance with current Wyoming Occupational Health and Safety Rules and Regulations for Construction.
- N. The Contractor shall provide safety boxes or sheeting and bracing necessary to confine his work within the construction limits, to provide safe working conditions, to prevent damage and delay to the work, and to prevent the disturbing or settlement of adjacent road surfaces, foundations, structures, utility lines or railroad tracks. The Contractor shall be responsible for the strength and sufficiency of all sheeting and bracing.
- O. Any damage to the work under this contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins, or other reasons due to failure or lack of sheeting and bracing, or improper bracing, or through negligence or fault of the Contractor in any manner, shall be repaired by the Contractor without delay and at his expense.
- P. Bracing shall be so arranged as to provide ample working space, so as not to interfere with the work, and so as not to place any strain on the structures being constructed, until such structures are of sufficient strength to withstand such strain. No sheeting

and bracing shall be removed until the construction has proceeded far enough to provide ample strength for its safe removal.

1. Sheeting or bracing may be left in place in the trench at the discretion of the Engineer. Any sheeting or bracing left in place shall be cut off approximately three feet (3') (900mm) above the top of the pipe or two feet (2') (.6m) below finish grade, whichever is lower, and the cut-off portion removed. All sheeting or bracing left in place shall be accurately located and shown on the "Record Drawing" (See Division 600 Section 601.12 of these specifications.)

Q. The Contractor shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, shoring, and blasting operations to conform to OSHA regulations.

R. The Contractor, if required by site conditions, shall provide a dewatering operation. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.

1. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12")(300mm) or more below the bottom of the excavation.
2. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.
3. The Contractor shall be responsible for the conditions of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
4. In areas where dewatering is required, the Contractor will comply with the following requirements:
 - a. All discharges from dewatering systems, including well points, dewatering wells, pumps in the bottoms of the trenches, etc. will require a permit from the Wyoming Department of Environmental Quality (DEQ). Before starting any construction, the Contractor shall submit an application to discharge to the DEQ along with a proposed dewatering plan for review. The application shall be submitted on "National Pollutant Discharge Elimination System, Application to Discharge from a Construction Project, Short Form E". If the

dewatering plan is revised during construction, the Contractor shall immediately send a revised plan to the DEQ.

- b. If there is any evidence of hydrocarbon or other contamination of the discharge water the discharge shall immediately cease and the WDEQ shall be notified immediately. The Contractor will then comply with DEQ conditions.
- c. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineer with the application for an excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineer.

S. PCE Testing Requirements

- 1. Where groundwater contamination is known or suspected, the Contractor shall provide PCE air and water testing services. These services will be required on all excavations where dewatering activities are required and where PCE groundwater contamination is known or suspected. The Contractor shall provide said testing as performed by a certified testing laboratory, and by certified testing methods, and subject to approval of Engineer and City.
- 2. The Contractor shall provide testing services for the following air and groundwater contamination sampling requirements. All results shall be submitted to Engineer and the City.
 - a. Air Sampling. One instantaneous test per fifty-feet (50') (15m) of trench shall be taken as the excavation progresses. Results are to be obtained by detector tube test or Organic Vapor Analyzer, or other similar device. These devices must be capable of detecting air quality parameters within the maximum time weighted average (TWA) detection limits for an eight (8) hour period as set by OSHA.
 - b. Should air sampling test results yield concentrations higher than those set by Wyoming Occupational Health and Safety Commission, Contractor is to immediately notify the Engineer, Owner, City, and DEQ and take the appropriate precautions to inform and protect workers and the public from the contaminant. There are several possible methods for protecting against the contamination some of which include natural trench ventilation, mechanical ventilation, protective clothing and breathing apparatus for workers and combinations of the above. These protective actions shall be the sole

responsibility of the Contractor and he shall use workers, equipment, and methods approved by OSHA for the types of soil contaminants encountered.

- c. Groundwater Sampling. One (1) groundwater PCE contamination analysis shall be taken per stationary excavation site, and two (2) tests per pipeline. Detection limits for water testing shall be 0.50 micrograms per liter (0.50 ppb).
- d. Should water sampling test results yield concentrations higher than those set forth by the EPA Manual Guidance of the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program, Dec. 1987, the Contractor is to immediately notify the Engineer, Owner, and DEQ, to help coordinate a course of action.

T. Volatile Organic Compound Sampling

1. For those sites with known or suspected soil contamination, the Contractor shall provide for ongoing volatile organic compound (VOC) monitoring of the air (similar to that described for PCE air monitoring) in the breathing zone of the trench and associated working areas. Monitoring shall be performed using an organic vapor analyzer (OVA) or other similar device, capable of detecting air quality parameters within the maximum time weighted average detection limits for an eight-hour period as set by OSHA. All VOC monitoring shall be performed by a trained and competent environmental testing service, subject to prior approval of the Engineer, Owner, and City.
2. If and when the VOC level for any breathing zone test exceeds 5.0 milligrams per liter (5.0 ppm), the Contractor shall immediately notify the Engineer, Owner, City, and DEQ and take the appropriate precautions to inform and protect workers and the public from the contaminant. There are several possible methods for protecting against the contamination some of which include natural trench ventilation, mechanical ventilation, protective clothing, and breathing apparatus for workers and combinations of the above. These protective actions shall be the sole responsibility of the Contractor, and he shall use workers, equipment, and methods approved by OSHA for the types of soil contaminants encountered.
3. The necessary ventilation and protective equipment will be expected to be readily available when the need arises if VOC (and PCE) contamination is encountered. The cost of any interruptions or reduction in work efficiency

resulting from VOC contaminated soils (and PCE) shall be borne solely by the Contractor.

601.04 Laying of Pipe

- A. Contractor shall provide all plant, equipment, labor, and material necessary for the safe and convenient prosecution of the work. Pipe manufacturer's installation instructions shall be followed and supplemented by these specifications.
- B. The sewer pipe shall be carefully lowered into trench piece by piece by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to the protective coatings and linings. The use of chains is not allowed. Under no circumstances shall sewer main materials be dumped into the trench. Any damage to pipe coatings shall be repaired with the same materials used for the original coating before laying the pipe.
- C. Before lowering and while suspended, the pipe and fittings shall be inspected for defects and to detect any cracks. Any defective, damaged, or unsound material shall be rejected.
- D. All foreign matter or dirt shall be removed from the inside of the pipe before it is lowered into its position in the trench, and it shall be kept clean by approved means during and after laying. All openings along the line of the sewer shall be securely closed as directed and, in the suspension of work at any time, suitable watertight stoppers shall be placed to prevent earth, water or other substances from entering the main.
- E. Sewer piping shall be laid to the lines and grades indicated in the Contract Documents. Methods of maintaining alignment and grade, such as use of laser beam equipment or surveying instruments, shall be used.
- F. Fine grading of the trench bedding beneath the pipe shall proceed ahead of the pipe laying. Unauthorized over-excavation shall be backfilled with bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to 95% of maximum density (Standard Proctor).
- G. Bell holes shall be dug for the pipe bells or couplings and the materials placed along the preceding pipe laid. The pipe shall be supported for the bottom 60 degrees and throughout its length (except for the minimum distance necessary at the bell holes). Bell holes shall be adequate to make the joint, but no larger than necessary, so that maximum support on the prepared bedding beneath the pipe will be provided. The remainder of the pipe shall be surrounded to at least its midpoint by granular bedding

material shovel-placed and hand-held machine tamped in maximum six-inch (6") (150mm) layers to completely fill all spaces under and adjacent to the pipe.

- H. No pipe shall be laid in water, on frozen ground, or when the trench conditions are unsuitable for such work.
- I. Pipe laying should proceed upgrade with the spigot ends pointed in the direction of the flow. The Contractor shall make all connections of pipe to the manholes that have previously been constructed.
- J. When connecting to existing sewers, the Contractor shall take every precaution necessary to prevent dirt or debris from entering the existing lines. The Contractor shall use an approved water-tight plug to securely plug the new sewer at the connection to the existing sewer immediately after the connection has been made. The plug shall be braced as necessary and tied to the manhole by a rope or chain. This plug shall remain until the new sewer mains have been accepted by the City or until otherwise directed by the City.
- K. Installation for pipelines using flow-fill as foundation, bedding, encasement, or backfill material shall be as follows:
 - 1. The mix design for flow-fill shall meet the requirements of Division 200, Section 205.05 Control Density Backfill Mixture Requirements.
 - 2. Assembly must be done under dry conditions with all joints completely cleaned of dirt and contaminants. Pipe ends and joints shall be kept covered until connection with next pipe segment. All joints shall be lubricated in accordance with the manufacturer's recommendations and assembled by pushing the spigot into the bell until the reference mark on the pipe barrel is flush with the end of the bell.
 - 3. The pipe to be embedded in flow-fill can be laid on a four to six-inch (4" – 6") (100mm – 150 mm) bed of washed gravel that has been excavated for the bells so that the pipe is uniformly supported along its entire length, or the pipe can be set on four-inch (4") (100mm) high blocks spaced no further than every five feet (5') (1.5m). The flow-fill or washed gravel must bear on undisturbed trench bottom. If necessary, Contractor shall stake the pipe to prevent lateral movement or floating during the placement of the flow-fill. The flow-fill must be placed carefully under and around the pipe and extend from undisturbed trench sidewall to sidewall. Placement may be by chute, bucket, or other means to assure that the line and grade of the pipe or pipes is maintained. The flow-fill must extend to at least two inches (2") (50mm) above the top of the pipe.

L. Installation for pipeline crossings using flow fill shall be as follows:

1. Whenever possible, the pipes should be laid so there are no joints or taps within nine feet (9') (2.7m) of the crossing. The flow-fill shall extend from undisturbed earth at the bottom of the lower pipe to at least two inches (2") (50mm) above the top of the upper pipe and extend from one side of the trench to the other. Pipes crossing one another can be separated by as little as four inches (4") (100mm) when embedded in flow-fill. The flow-fill installation must be wide enough to ensure the structural integrity of the installation.
2. All sewer services crossing over water mains must be encased in flow-fill in accordance with the provisions of the above specification.
3. There shall also be a concrete flow-fill barrier between City lines and high-pressure petroleum lines.

M. Testing of flow-fill joints.

1. Where sections of existing sanitary sewer lines are replaced by new lines, pressure testing shall be performed. If pressure testing is not possible, then verification that the gaskets are properly seated (not buckled out of gasket groove) must be performed. Verification can be performed by inserting a thin metal gauge between the bell and the spigot around the entire circumference of the joint. The edge of the gauge must penetrate only to a reference mark on the gauge that indicates the depth of a properly seated gasket.

601.05 Installation of Manholes

- A. Excavation shall be to a depth and size to provide for construction of the manhole. Concrete bases shall be poured on undisturbed ground. Precast concrete bases shall be carefully lowered onto one of the following:
1. Six-inches (6") (150mm) minimum layer of well compacted granular material accurately laid to a smooth level surface using a straight edge and hand level.
 2. Three inches (3") (75mm) of concrete poured on undisturbed soil.
- B. Walls shall be of precast concrete as shown in the standard drawings and shall be constructed to form a complete watertight structure.

- C. The Contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two-inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight in accordance to Drawing D2. Wood will not be allowed as spacers. Adjusting rings shall conform to the size and shape of the casting frame. Frames and covers shall be set to the designated elevation in a full mortar bed.
1. The minimum two-inch (2") (50mm) concrete ring for grade is not needed if grade can be met with a six-inch (6") (150mm) flange on top of the cone section of the manhole.
 2. If the number of adjusting rings exceeds the maximum twelve inches (12") (300mm), the manhole shall be reexcavated and a manhole barrel section installed.
- D. Manholes shall be set as shown on Drawing 601/2, and 601/3. All lifting holes must be grouted in after placement.
- E. Riser rings, if approved by the engineer, shall be a minimum of two inches (2") (50mm) or greater in height. No aluminum risers shall be used. In gravel or unpaved roads, the manhole ring shall be kept one to two inches (1"-2") (25mm-50mm) below the road surface.
- F. In asphalt paving areas, where patching material is required around the manhole covers, asphaltic material shall be required in the top two inches (2") (50mm) of the street.
- G. The invert of all manholes shall be smoothly shaped so as to allow a free, uninterrupted flow of sanitary sewage. The invert forming system shall be "A-Lok Tru Contour", or approved equal.
1. Floor troughs shall be furnished for all sewers entering manholes. Inverts shall be U-shaped to the 1.0 diameter point before sloping at a 1 to 12 slope to the manhole walls.
 2. Unless approved by the Engineer, the sanitary sewer pipe should be laid continuously through the manholes and cut out when the manhole invert is finished. Manhole couplings or other acceptable water stops (i.e. PVC pipe gasket stretched over outside of pipe, Ram-Nek, etc.) must be used when

connecting PVC pipe to manholes. After the installation of the pipelines into the manhole, the interior annular space around the outside of the pipe shall be sealed with grout.

- A. Fittings for drop manholes shall consist of a wye and a ninety-degree bend. (see Drawing 601/2) unless otherwise shown in the Contract Documents or approved by the Engineer. Clean out pipe on drop manholes will penetrate the inside of the manhole twelve inches (12") (300mm) to fourteen inches (14") (350mm) with the top half of the pipe cut out. The entire drop inlet piping arrangement shall be encased in mass concrete having a twenty-eight (28) day compressive strength of at least four thousand pounds per square inch (4,000psi) (27,600 kPa).

601.06 Backfilling and Grading

- A. All excavation in trenches shall be backfilled to the original ground surface or to such grades as specified or as shown on the drawings. The backfill shall begin as soon as practical after the pipe has been placed and shall thereafter be carried on as rapidly as the protection of the balance of the work shall permit.
 - 1. No pipe shall be covered before the Project Representative or the Engineer has observed and approved the pipe. If any piping or appurtenance is covered without the approval of the Engineer or Resident Project Representative, at the discretion of the Engineer, the Contractor shall be required to re-excavate to expose the covered materials. The cost of exposing those materials and then backfilling and recompacting will be at the Contractor's expense regardless of the condition of the pipe and/or the materials under question.
 - 2. The Contractor shall completely backfill all excavations before stopping work at the end of each day. Open excavations (fenced or unfenced) will not be allowed overnight, on weekends, or after work at any site after work has stopped for the day, unless approved by the City.
- B. Complete cleanup shall proceed directly behind the backfilling operation to accommodate the return to normal conditions. Should the Contractor, in the City's opinion, fail to pursue diligently the backfilling and cleanup, the amount of work on which complete cleanup has not been accomplished shall be limited to one thousand lineal feet (1,000') (300m) for the entire job. The Contractor shall have sufficient equipment on the job to assure timely backfill and cleanup at all times.

- C. Backfilling and compacting shall be done to meet Division 600 Section 601.06L of these specifications. Depositing of the backfill shall be done so the impact of falling material will not injure the pipe or structures. Grading over and around all parts of the work shall be done as directed by the Engineer.
1. Where excavations occur in unpaved surfaces, such as alleys but not previously turfed areas, the area shall be restored by placing a minimum of two inches (2") (50mm) of stabilized gravel on the surface of the excavation. Stabilized gravel shall be equal to material meeting coarse aggregate for minimum three-fourths inch (3/4") (20mm) as specified in the Division and Section related to Street Construction.
- D. Granular bedding material shall be deposited in the trench simultaneously on both sides of the pipe for the full width of the trench to a height at least to the mid-point of the pipe. The bedding material shall be shovel placed and hand-held machine tamped in maximum six-inch (6") (150mm) layers to completely fill all spaces under and adjacent to the haunches of the pipe. Encasement material will then be placed around and over the pipe to a height of at least twelve inches (12") (300mm) above the top of the pipe, but need not be hand-placed. Granular encasement material, as specified, must be used for all pipe.
- E. Succeeding layers of backfill above the twelve-inch (12") (300mm) level may contain coarse materials not exceeding three-inches (3") (75mm) in the largest dimension, but shall be free from large pieces of rock, frozen material, concrete, roots, stumps, tin cans, rubbish, and other similar articles whose presence in the backfill would, in the opinion of the Engineer, cause settlement of the trench or damage to the pipe. Whenever select material that exists in place in the upper four feet (48") (1.2m) of the finished grade of the paved or traveled portions of the street or roadway, is removed by the trench excavation, the Contractor shall replace said material (or material of equal quality) as backfill in the upper four feet (48") (1.2m) of the finished grade. Where select material does not exist in place as described above, the Contractor shall provide and place sufficient select backfill to stabilize the finished grade as directed by the Engineer.
- F. Backfilling shall be done in lifts of uniform layers which will produce the required compaction. Each lift shall be completely compacted over the full width of the excavated area. Compacting shall continue until the specified relative compaction has been attained or until no more settlement occurs. Water jetting of backfill shall not be permitted.
- G. Groundwater barriers shall be placed at maximum three hundred feet (300') (90m) intervals or where directed by the Engineer. These shall be provided to interrupt the passage of water through the foundation, bedding, encasement, and select backfill material. The barriers shall be compacted to 95% of maximum density (Standard

Proctor) the full depth of the granular material, the full trench width and a minimum of three-feet (3') (900mm) long.

- H. Special attention shall be given to the compaction operation performed around all manholes, valve boxes, curb boxes, other structures, and utilities by the use of pneumatic tampers, plate tampers, or plate vibrators to obtain the required compaction requirement.
1. Structure backfilling shall cover manholes, valve boxes, curb boxes, and any other structure encountered during the course of the work. Fill around structures shall consist of trench backfill meeting the requirements of bedding and encasement material or select backfill material. Fill material shall be spread and compacted to provide continuous and uniform support around the structure.
 2. Do not place fill when the surface to be filled is snow covered or frozen. Do not place frozen fill.
 3. Fill around concrete structures shall commence only after concrete has attained 80% of the ultimate compressive strength specified. Remove all form materials, concrete spills, and trash from around the structures before placing fill. Where backfilling on both sides or around the perimeter of a structure is required, place the backfill and compact simultaneously at the same elevation on opposite sides or around the perimeter in lifts.
 4. Place fill material in eight-inch (8") maximum lifts and compact to at least 95% density for cohesive soils and 70% relative density for non-cohesive soils. The moisture content shall be plus or minus 2% of optimum.
 5. Flowfill, as described in Section 205.05 shall be used from a distance of three feet (3') (1 m) horizontally from the bottom of the manhole to the bottom of the road base coarse.
- I. Sewer service trenches shall be compacted in the same manner as the sewer main trenches. In streets open to traffic, service trenches must not be left open overnight. In areas where curb and gutter exist, sufficient curbing shall be removed to allow this compaction over the entire disturbed area.
- J. All deficiencies in the quantity of material for backfilling the trenches or for filling depressions caused by settlement shall be supplied by the Contractor. Any excess material shall be hauled away and disposed of in a legal manner at no additional compensation.
- K. No waste material or debris shall be deposited on any public or private property without the written permission of the Engineer. Waste material and debris shall include, but not be limited to trees, stumps, pieces of pipe, pieces of concrete, pieces of asphaltic concrete, tin cans, or other waste material from the construction operations. Disposal of this material shall be the responsibility of the Contractor.

- L. The in-place density of the compacted soil shall be determined by the Engineer using either ASTM standard test method D1556-82 (sandcone), AASHTO T 238-97, or ASTM standard test method D2722-81 (nuclear). The maximum density of the soil shall be determined by ASTM standard test method D698 (standard proctor). The in-place density must not be less than the following percentages of the maximum density in paved areas, areas to be paved, and graveled areas:
1. 95% compaction from twenty-four inches (24") (600mm) above top of pipe to the finished surface, except that in no case shall this 95% compaction zone be less than forty-eight inches (48") (1.2m) deep.
 2. 90% compaction from pipe zone to start of 95% compaction zone.
 3. The compaction required outside paved areas, outside areas to be paved or outside graveled areas shall be 90%.
 4. The compacted backfill shall have a moisture content of $\pm 2\%$ of optimum moisture.
- M. The Engineer shall determine the frequency and number of tests to be conducted to measure the gradation, density, and moisture of the backfill. Minimum testing frequency is as follows:
1. Gradation Tests
 - a. Pipe Zone Material. One initial gradation test for each type of material plus one additional test for each 5,000 cubic yards (5,000 yd³) (3,750 m³) or portion thereof placed of each material.
 - b. Foundation Material. One initial gradation test for each type of material plus one additional test for each 1,000 cubic yards (1,000 yd³) (750 m³) or portion thereof placed of each material.
 - c. Bedding and Encasement Material. One initial gradation test for each type of material plus one additional test for each 10,000 cubic yards (10,000 yd³) (7,500 m³) or portion thereof placed of each material.
 - d. Select Backfill Material. One initial gradation test for each type of material plus one additional test for each 10,000 cubic yards (10,000 yd³) (7,500 m³) or portion thereof placed of each material.

- e. All gradation tests shall be the responsibility of the Contractor using a certified approved soils testing laboratory acceptable to the Owner and Engineer. The Contractor shall be responsible for all costs associated with gradation testing.
2. Density and Moisture Test.
- a. Pipe Zone Material. One test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
 - b. Foundation Material. One test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
 - c. Bedding and Encasement Material. One test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
 - d. Select Backfill Material. One test for each one thousand cubic yards (1,000 yds³) (750 m³) or portion thereof placed of each material.
 - e. Job Excavated Select Backfill Material. Tests shall be taken as arranged by the Engineer.
 - f. Unless otherwise indicated in the Contract Documents, density and moisture tests shall be the responsibility of the Engineer. The Contractor shall cooperate with the Engineer or the soils testing agency in taking density and moisture tests.
- N. When the trench excavation for the sewer main and appurtenances is within the rights-of-way of state or county highways, the backfilling of the trench, compaction of materials, subgrade preparation and surfacing shall be done in strict accordance with the requirements and specifications of the authority having jurisdiction or as required by these specifications, whichever is more stringent.
- O. In all cases, the Contractor shall blade and compact the roadway after the trench has been backfilled, so that it shall be passable to traffic at all times. The Contractor shall maintain the roadway in a condition acceptable to the City at all times until final acceptance of the entire work by the City.
- P. The Contractor shall also blade and maintain all detours and bypasses. All maintenance work shall be done at no additional compensation. In addition to the

blading and maintenance requirements specified, the Contractor shall provide at least one tank truck with pressurized spray bars for spraying water on the streets to control the dust. Dust control shall be required as necessary on all streets after compaction and grading and on all detours and bypasses.

- Q. The Contractor is responsible for the complete maintenance of his work at all times. If he fails to provide proper maintenance, and safety or nuisance conditions arise, it is expressly understood that City crews may be directed by the City to provide essential maintenance, and that such work will be done at the expense of the Contractor.
- R. The Contractor shall remedy at his own expense any defects that appear in the backfill following completion and during the warranty period.

601.07 Service Connections

- A. It shall be the duty of the Contractor to keep an accurate record of service connections as to the location, elevation of the service at the property line, type of connection provided, and other pertinent data and to include this information on the record drawings. Locations shall be made in respect to the survey line stationing and house corners or lot corners. The Engineer, prior to any backfill, shall approve all service installations.
- B. The Contractor shall construct services for building connections and shall extend such services to the back of the utility easement. Service connections shall have a wye or tee installed at the main line. The sewer lateral will be aligned at a 90 degree angle with the main line. Service connections shall not enter at an angle greater than 45 degrees from the horizontal. Contractor shall leak test all new service lines in conjunction with new sewer mains being leak tested.
- C. Sewer service riser pipes shall not be installed directly into the main line. The bottom section of the sewer service line (installed at an angle not greater than 45 degrees from the horizontal) shall be a minimum length of eighteen inches (18") (450 mm) between the main line and the riser pipe installed at a grade not greater than 1/2 – inch per foot. The trench bottom below the bottom sections and the riser of the sewer service line shall be compacted to support the sewer service riser pipe. Riser pipes shall be laid against the trench wall to help prevent drag down loading from soil settlement. An engineer will design all sewer service riser pipes where the depth of the main line is twelve feet (12') (3.6m) or greater.
- D. Sewer services shall be installed ten feet (10') (3m) from the lot centerline on the downhill side of the sewer main. Services may be installed at a greater distance from the centerline if required by the sewer elevation. Services shall be installed perpendicular to the sewer main between the main and the property line.

- E. Sewer service lines shall be kept as deep as required to serve the property and shall extend on a straight-line grade to the property line unless otherwise directed by the Engineer. Where possible, all sewer service connections shall end above the groundwater table.
 - 1. All sewer service connections shall be capped with stoppers which shall effectively prevent water from entering the sewer until the connection is placed in service. The cap shall be as recommended by the pipe manufacturer, sealed firmly in place, or by other methods accepted by the Engineer. The service connection end shall be clearly marked by a rebar extending from the pipe end to at least three feet (3') (1m) above the ground. The service line location shall also be marked in the concrete curbwalk by an arrow with the letter "S".
- F. In some areas, the sewer services may be laid at the minimum grade allowed by the plumbing code in effect due to a shallow sewer line or low abutting property. Services shall be at right angles to the main sewer unless otherwise directed by the Engineer.
- G. Groundwater barriers shall be placed on all service lines at the property line. The barrier shall be compacted to 95% of maximum density (standard proctor) the full depth of the granular material, the full trench width, and a minimum of three feet (3') (1m) long.
- H. Where it is necessary to tap sewer services into existing mains, the City shall make the taps for the Contractor using saddle adapters. The Contractor shall be responsible for installing the service line from the installed tap to the property. The Contractor shall be responsible for obtaining a street cut permit, laying out and excavating the trench, protecting all mains and service pipes and backfilling the excavation in an approved manner. Contractor shall adhere to OSHA trenching and shoring rules and regulations.
- I. All abandoned or unused sewer service lines must be plugged at the property line and capped with a watertight stopper.
- J. All townhouse "manifold" systems shall meet the material and installation requirements of the "Sanitary Sewerage Collection Facilities Design Standards", these specifications, and the Uniform Plumbing Code as adopted by the City of Casper.

601.08 Leak Testing

- A. Upon completion of all utility construction and before any sewer service line is connected into, leak testing will be required of all sanitary sewer pipe lines. The Contractor has the option of performing either an air test or a water exfiltration test. Testing shall be performed after complete compaction and backfill and completion of

manholes, but may be performed before the final surfacing.

1. Leak testing, using low-pressure air shall be performed with suitable equipment specifically designed for air testing sewers.

a. The air test shall be made when the sewer is clean. Sections of sewer pipe to be tested may be wetted before the air test. The pipeline shall be plugged at each manhole with pneumatic balls. Low-pressure air shall be introduced into the plugged line until the internal pressure reaches four-pounds per square inch (4.0 psig) (28 kPa) greater than the average back pressure of any groundwater pressure that may submerge the pipe. At least two (2) minutes shall be allowed for the air temperature to stabilize before readings are taken and the time started.

b. The portion of the sewer line being tested shall pass if it does not lose air at a rate to cause the pressure to drop from three and one-half to three-pounds per square inch (3.5 psig - 3.0 psig) (24 kPa – 21 kPa) (greater than the average back pressure of any groundwater that may submerge the pipe) in less time than listed below.

Pipe Diameter in.(mm)	Minimum Time (min. sec.)	Specified Time for Length (L) Shown (min:sec)								
		100' (30m)	150' (45m)	200' (60m)	250' (75m)	300' (90m)	350' (105m)	400' (120m)	450' (135m)	
4(100)	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	
6(150)	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12	
8(200)	3:47	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42	
10(250)	4:43	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54	
12(300)	5:40	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50	
15(375)	7:05	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02	
18(450)	8:30	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51	
21(525)	9:55	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16	
24(600)	11:20	1:24	17:57	22:48	28:30	34:11	39:53	45:35	46:54	
27(675)	12:45	14:25	21:38	28:51	36:04	43:16	50:30	57:42	51:17	
30(750)	14:10	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07	
33(825)	15:35	21:33	32:19	43:06	53:52	64:38	75:25	86:11	96:58	
36(900)	17:00	25:39	38:39	51:17	64:06	76:56	89:45	102:34	115:24	

c. If the pipeline section fails this test, the testing equipment may be used to determine the location of the pipe lea.

d. All service plugs shall be secured in place to prevent displacement during testing operations.

2. In lieu of the standard sanitary sewer air test, the Contractor may perform

leakage testing on sewers using water and measuring the exfiltration.

- a. The test section shall be bulkheaded at both ends and the pipe subjected to a hydrostatic pressure produced by a head of water at a depth of three feet (3') (1m) above the top of the sewer at the upper manhole under this test. In areas where ground water exists, this head of water shall be three feet (3') (1m) above the existing water table. For purposes of the test, the line between adjoining manholes will be considered a section and will be tested as such.
- b. The head of water shall be obtained by means of an open ended stand-pipe projecting from a test plug on the upper manhole. Placing water in the upper manhole is not permissible as a means of obtaining the necessary pressure head of water.
- c. This head of water shall be maintained for a period of one (1) hour during which it is presumed that full absorption of the pipe body has taken place, and thereafter for a further period of one (1) hour for the actual test of leakage. During this one (1) hour test period, the measured maximum allowable rate of exfiltration for any section of sewer, including service stubs, shall be listed below:

MAIN SEWER DIAMETER	MAXIMUM ALLOWABLE EXFILTRATION
<u>inches(mm)</u>	<u>Gallons Per Hour Per 100 feet(l/hr/30m)</u>
4 (100mm)	0.6 (2.2)
6 (150mm)	0.9 (3.4)
8 (200mm)	1.2 (4.5)
10 (250mm)	1.5 (5.5)
12 (300mm)	1.9 (7)
15 (375mm)	2.3 (9)
18 (450mm)	2.8 (10.5)
21(525mm)	3.3 (12.5)
24 & larger (600mm)	3.8 (14)

- d. In case measurements indicate an exfiltration greater than the maximum allowable leakage, additional measurements shall be taken and continued until all leaks are located and the necessary repairs and corrective work have reduced the leakage in the section being tested below the maximum allowable by the specifications.
3. The Contractor shall furnish the plugs, standpipe, and other material and labor for placing the plugs and standpipe in the sewer.
 4. The introduction of any substance into the water used for testing with the intent of sealing such leaks as may be indicated will not be permitted.

5. If results of either of these leakage tests are not satisfactory, repairs or pipe replacement will be required until the Engineer is satisfied that the leakage requirements are being met. All repair methods and materials used shall be approved by the Engineer.
- B. Manholes will be tested for leakage separately from the pipe. Manholes shall be filled with water to a depth of five feet (5') (1.5m) above the invert or five feet (5') (1.5m) above the groundwater table whichever is higher. If the groundwater level is more than five feet (5') (1.5m) above the invert, inflow to the manhole shall be measured. Allowable leakage into or out of or both shall be one gallon per hour (1g/h) (3.75l/h) per manhole measured over a minimum four (4) hours. At least 20% of all manholes shall be tested. Based on these tests, and visual inspection of all manholes, additional tests may be required for other manholes. Any manhole whose test is unsatisfactory shall be repaired and retested until satisfactory results are obtained.

601.09 PVC Deflection Test

- A. All PVC pipe shall be subject to a deflection test by use of cage type approved mandrel.
1. In paved areas or areas to be paved, the Contractor has the option of:
 - a. Testing PVC sewer lines with a 4% deflection mandrel after complete backfill and compaction of trench but before paving, or
 - b. Testing PVC sewer lines with a 5% deflection mandrel after paving is complete.
 2. In non-paved areas Contractor has the option of:
 - a. Testing PVC sewer lines with a 4% deflection mandrel after complete backfill and compaction of trench but before placing and spreading topsoil, or
 - b. Testing PVC sewer lines with a 5% deflection mandrel after placing and spreading topsoil (but before seeding).
- B. All mandrels shall be precisely made to the diameters specified below (which include allowances for pipe manufacturer's outside diameter tolerance, excess wall thickness tolerance, and out-of-roundness tolerance).

<u>NOMINAL PIPE DIAMETER</u>	<u>MANDREL MINIMUM O.D. FOR 4% DEFLECTION</u>	<u>MANDREL MINIMUM O.D. FOR 5% DEFLECTION</u>
8”(200mm)	7.358” (187mm)	7.282” (185mm)
10” (250mm)	9.180” (233mm)	9.085” (231mm)
12” (300mm)	10.907” (277mm)	10.793” (274mm)
15” (375mm)	13.342” (339mm)	13.203” (335mm)
18” (450mm)	16.297” (414mm)	16.127” (410mm)
21” (525mm)	19.204” (488mm)	19.004” (483mm)
24” (600mm)	21.581” (548mm)	21.356” (542mm)
27” (675mm)	24.314” (618mm)	24.061” (611mm)

* O.D. – Outside Diameter

601.10 Separation of Water Mains and Sewers.

- A. Minimum horizontal separation shall be ten feet (10’) (3m) where the invert (bottom) of the water main is less than eighteen inches (18”) (450mm) above the crown (top) of the sewer line. Minimum vertical separation shall be eighteen inches (18”) (450mm) at crossings. Joints in sewers at crossings shall be located at least ten feet (10’) (3m) from water mains. The upper line of a crossing shall be specially supported. Where vertical and/or horizontal clearances cannot be maintained, the sewer or water piping shall be placed in a separate conduit pipe.
- B. Flow fill may be used in lieu of the separation requirements listed above in accordance to Section 205.5.

601.11 Inspection and Acceptance

- A. Prior to acceptance of each section of sanitary sewer line, the Contractor shall flush a ball the full diameter of the pipe through all pipelines up to eighteen inches (18”) (450mm) in diameter. Larger pipelines shall be cleaned by other appropriate methods. All dirt and debris shall be prevented from entering the existing sewer system by suitable methods.
- B. Preliminary Acceptance
 - 1. Prior to preliminary acceptance of a sanitary sewer collection system, regardless of ownership, the following inspection tests shall be made and certified for each section of sewer line.

- a. Gradation tests. Copies of the test results shall be enclosed as an attachment to the “Certificate of Completion”.
 - b. Density and moisture tests. Copies of the test results shall be enclosed as an attachment to the “Certificate of Completion”.
 - c. Air tests or exfiltration tests. Copies of the test results shall be enclosed as an attachment to the “Certificate of Completion”.
 - d. Deflection test (PVC). Copies of the test results shall be enclosed as an attachment to the “Certificate of Completion”.
 - e. Cleaning and flushing of the lines and manholes.
- 2. Each manhole shall be inspected for:
 - a. Proper construction. The invert of the manholes shall be smooth, clean, and free of obstructions.
 - b. Leakage.
 - c. Cover accessible and at proper grade.
 - 3. Items 1.c. and 1.d. above shall be performed only after complete backfill and compaction; items 1.e. and items 2.a., 2.b., and 2.c. shall be performed after an all-weather roadway is completed and complete easement restoration is accomplished.
 - 4. The “Certificate of Completion” and “Record Drawings” shall be submitted to the City prior to preliminary acceptance.

C. Final acceptance

- 1. Final acceptance will not take place until preliminary acceptance is obtained and all paving and curbside is completed.
- 2. Before final acceptance of any sanitary sewer, the following inspections shall be made:
 - a. All lines clean and flushed.
 - b. Manholes up to proper grade in a proper condition.
- 3. All punch list items must be completed prior to final acceptance.
- 4. The warranty period shall not start until final acceptance is obtained and a complete set of “Record Drawings” is submitted to the City.

601.12 Record Drawings

- A. “Record Drawings” shall be submitted to the City prior to preliminary acceptance of the construction project. “Record Drawings” shall include, in addition to construction drawings and details, “as built” information where it differs from construction drawings and locate information including horizontal and vertical coordinates in the datum established by the City for the Geographical Information System.

601.13 Standard Detail Sections

- 601/1 Typical Street Cut Section Asphalt Surfacing
- 601/2 Standard Sanitary Sewer Manhole Detail
- 601/3 Standard Manhole Frame and Cover Grade Adjustment Detail
- 601/4 Sewer Service Line Detail

DIVISION 600

SECTION 602

STORM SEWERS AND CULVERTS

602.01 Description.

This section covers storm sewer and culvert materials, excavation, trenching, and backfilling for storm sewers and appurtenances. Work shall consist of removal of all material of whatever description that may be encountered; removal and disposal of debris; handling and storage of materials; all necessary bracing, shoring, and protection; pumping and dewatering as necessary; all backfill preparation of subgrades; and, final grading, dressing, and surface restoration cleanup of the site.

602.02 Submittals.

Before the fabrication of the pipe and manholes is started, the contractor shall submit for review, drawings showing the pipe lengths, complete laying schedule, joint details, special sections, and other additional details, such as fittings. All pipe and manholes furnished shall be fabricated in accordance with the reviewed drawings. Manufacturer's certificates of compliance and installation recommendations shall be provided to the City prior to construction.

602.03 Materials.

The materials furnished for the storm sewer pipe and culverts shall be equal to or shall exceed the following requirements.

A. Storm Sewer Pipe and Culverts.

1. Concrete Pipe. Reinforced concrete pipe (RCP) shall conform to the requirements of ASTM C76, latest revision, as modified in this Section. Non-reinforced concrete pipe shall meet the requirements of ASTM C14 for sizes twelve-inch to thirty-inch (12" to 30"). Horizontal elliptical reinforced concrete pipe (HERCP) shall conform to the requirements of ASTM C-507, latest edition. Precast concrete box culverts shall conform to the requirements of ASTM C-1433, latest revision. Reinforced concrete pipe items and concrete box culvert items shall be manufactured in a plant that is certified by the American Concrete Pipe Association.

Minimum wall thickness' shall be "Wall B" in referenced specifications C76 and C14 of ASTM. Except for special pieces, each joint shall be at least seven and one-half feet (7'6") (2.3m) in length. The class of pipe required shall be shown on the drawings. The cement used in manufacturing reinforced concrete pipe shall be Type II, modified low C3A (less than 5%) or Type V. Lifting holes will not be permitted in

any of the pipe, except elliptical pipe and box sections. Non reinforced concrete pipe must meet the same D-load requirements as reinforced concrete pipe. The Engineer may specify bedding type and fill height requirements.

Joints for the reinforced concrete pipe shall be either tongue and groove or bell and spigot. Unless deleted elsewhere in the specifications, a butyl mastic joint sealant will be installed in each joint. The sealant will be in rope or trowel-applied form, made specifically for permanently sealing joints in concrete pipe, must adhere tightly to the pipe surface, and must form a tight flexible joint. The sealant shall be installed as directed by the pipe manufacturer.

In addition to the certifications and bearing test results, the contractor shall furnish the Owner with mill test reports for all cement used to manufacture proposed pipe. The owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

2. Polyvinyl Chloride Pipe. Polyvinyl chloride (PVC) pipe shall conform to ASTM D-3034, SDR 35 for four inch (4") (100mm) through fifteen inch (15") (375mm) diameter, and ASTM F679 for eighteen-inch (18") (450mm) through twenty-seven inch (27") (675mm) diameter. The pipe shall have bell and spigot joints with an approved gasketed joint. Inert materials, such as limestone, shall not exceed ten (10) parts per one hundred (100) of the resin.
 - a. When special fittings such as wyes, tees, etc., are required, they shall be manufactured from the same material as the pipe and shall be made for use with PVC pipe. Connections to manholes and catch basins shall be made using O-ring gaskets whenever ground water is present; otherwise, catch basins and manholes may be grouted. Other suitable elastomeric boots may be used.

3. Corrugated Steel Pipe. Corrugated steel pipe (CSP), band couplers, and fittings, shall be manufactured in accordance with AASHTO M-36, latest edition, as revised in these specifications. All seams shall be joined in a manner that develops the full strength of the pipe and shall not affect the shape or nominal diameter of the pipe. The wall thickness of the steel shall be specified in the Special Provisions.
 - a. The materials used to coat the steel sheets shall be specified in the Special Provisions and may be one or more of the following types:
 - i. Zinc-coated (galvanized) steel sheets for annular pipe shall be coated in accordance with AASHTO M-218.
 - ii. Aluminum coated (Type 2) steel sheets shall be coated by the hot dip process in accordance with AASHTO M-274, M-36, and M-274.

- iii. Precoated (Polymeric) galvanized steel sheets shall be coated in accordance with AASHTO M-246 and M-245. The precoated sheets shall be Type C with a polymeric coating in a thickness of 0.010 inch (3mm) minimum on each side and edge of the sheets.
- b. After the fabrication of the pipe, the manufacturer will coat the cut ends of each section of pipe with the specified coating before shipping. Exposed uncoated metal at the ends of the pipe may be reason for rejection of the pipe.
- c. The CSP shall be joined together with coupling bands manufactured in accordance with AASHTO M-36. If coatings of the CSP are specified, the couplings shall be coated with the same materials. Unless otherwise specified, the couplings shall make a watertight joint.
- d. All pipe shall be inspected when delivered to the job site and prior to the unloading of the pipe. Any pipe damaged during shipping and/or handling will be rejected and will not be installed. If the exterior bituminous coating is damaged during installation, the contractor shall repair the coating using approved methods and materials. If the concrete lining is damaged during installation, the contractor shall remove and replace the damaged pipe at no expense to the owner.
- e. The pipe supplier shall prepare and supply the contractor with a pipe-laying schedule, and the Contractor's supervisor and superintendent and the owner's representative shall have these laying schedules available on the job site.
- f. Connections for the laterals and catch basin leads may be shop fabricated or made in the field. In some instances, field connections shall be required. All field connections shall be saw cut using a saber type saw and templates made for such use. Flame cutting shall not be allowed. After field cuts have been made, the exposed metal shall be coated with the specified coating. Coating materials shall be supplied by the pipe manufacturer. The connection shall be completed according to the manufacturer's recommendations.
- g. Installation of corrugated steel pipe is considered to be a flexible conduit and, therefore, special care must be taken during the bedding and backfilling operations. Installation and backfilling operations shall be in accordance with the recommended practices set forth in the "Handbook of Steel Drainage and Highway Construction Projects", published by the American Iron and Steel Institute.
- i. All pipe shall be bedded with an approved granular bedding material. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. Blocking shall not be used to bring the pipe to grade.

- ii. The bedding material shall be placed evenly on both sides of the pipe to a point twelve inches (12") above the top of the pipe. Special care shall be taken to insure that all voids are filled beneath the pipe haunch and that the bedding material is properly placed and compacted to provide lateral restraint. The trench sidewall shall be adequately braced, shored, or sheeted as necessary to stabilize the trench walls. The trench shall not be any wider than necessary for proper installation, and pipe jointing. The bedding material shall be placed under haunches and around the pipe alternately in 6-inch layers on both sides of the pipe to permit thorough consolidation of the bedding material. This material is placed alternately to keep it at the same elevation on both sides of the pipe at all times.
- iii. Removal of Trench Protection: Extreme care shall be taken in the removal of cribbing, shoring, sheeting, etc., so as not to disturb previously constructed foundation, bedding and initial backfill. If it was necessary to place or drive sheeting or other trench protection below the top of the pipe, the sheeting, shoring, etc., shall be cut off at a point one foot (1') above the pipe and the remaining material shall be left in place. Removal of this portion could seriously jeopardize the side support necessary for "flexible conduits" and create excessive lateral soils pressures and pipe deflections.
- iv. Protection of Conduit During Construction: Maximum supporting strength in flexible conduits does not develop until the fill consolidates. Therefore, excessive concentrated loads or heavy equipment on top of or along side of the pipe shall be avoided.

B. Manholes.

1. All manholes and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Manufacturer's certificates of compliance and installation recommendations shall be provided to the Engineer and City prior to construction.
 - a. All manholes shall be constructed with concentric precast sections without steps unless otherwise approved. Precast concrete manhole sections shall be manufactured to standards at least equal to or greater than the requirements of the standard specifications for precast reinforced concrete manhole sections, ASTM designation C478. The minimum internal diameter for storm manholes shall be forty-eight inches (48") (1.2m) unless shown otherwise. Manholes shall conform to all requirements as shown on the detail drawings. Precast manhole joints shall be made water-tight with RAM-NEK material, or approved rubber gasket at each joint. The RAM-NEK and primer must be used in accordance with the manufacturer's instructions. Rubber gaskets used for precast manhole joints shall be designed in accordance with ASTM designation C-443. All lifting holes must

be grouted. All cement for manholes shall be Type V Portland cement or modified Type II with equal sulfate resistant characteristics.

- b. The concrete base shall be cast-in-place or precast concrete of the size and depth shown on the drawings. Concrete used for bases shall have a twenty-eight (28) day compressive strength of at least four thousand pounds per square inch (4,000psi) (27,600 kPa). Approved precast concrete bases will be allowed if provided with an integral groove for barrel placement. Precast concrete bases shall conform to ASTM C-478. Manholes with the base monolithically poured with the bottom barrel are also acceptable and preferred.
- c. Precast manhole inverts shall be constructed using a secondary invert forming system designed to provide a finished invert that aligns precisely with the incoming pipelines, incorporating a finished flow depth of 0.8 to 1.0 diameter of the largest pipe. The completed precast invert shall include an alignment bench for each pipe, and provide for uniform horizontal and vertical transition through the manhole in accordance with drawings. Provide 0.1' (30mm) minimum fall between inlet and outlet. After the installation of the pipelines into the manhole, the interior annular space around the outside of the pipe shall be sealed with grout. The acceptable tolerances for manhole inverts are one-quarter inch (1/4") (6.25mm) in any dimension and within 2 degrees for alignment. The invert forming system shall be "a-lok tru contour", or approved equal.
- d. The manhole ring and cover shall be centered over the connection at the centerline of flow.
- e. For manholes with depths of six feet (6') (1.8m) or less, all of the precast manhole sections shall be of the specified diameter and shall have a flat, precast concrete top.

C. Catch Basins.

1. All catch basins, inlet boxes, and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Catch basins (storm inlets) shall be cast-in-place or precast concrete with dimensions as shown on the drawings or standard details.
 - a. Precast concrete catch basins shall comply with all the requirements of ASTM C858 and C857. Cast-in-place concrete basins shall be constructed of materials in accordance with Division 300, Section 301, Portland Cement Concrete.
 - b. The Contractor may elect to install pre-cast or cast-in-place catch basins.

D. Castings

1. Manhole frames and covers, and catch basins frames and grates shall meet the requirements of this Section unless specified otherwise in the Special Provisions or drawings.
2. Manhole frames and covers shall be six-inch (6") (150mm) heavy duty Neenah R 1726-A, D&L Supply A-1043, or approved equal. Heavy-duty manhole ring and cover shall have a minimum ring depth of six inches (6") (150MM).
3. Acceptable grates shall be determined by the design, hydraulic efficiency, and placement required. Additionally, grates must be suitable for use in areas where it is possible for handicap persons and pedestrians to be present. The adoption of the Americans with Disabilities Act (ADA), the prominence of narrow-tired bicycles and concern for pedestrian safety dictates the design considerations of storm water installations.

Grate selection criteria should include a combination of capacity, and functionality for the specific location. Directional and/or vane grates are not recommended at the low points of vertical curves, and shall be used only when approved by the Engineer.

Catch basin frames and curb box shall be Neenah R-3067, D&L Supply I-3517, or equivalent. I-3516 is recommended for use in the lowpoint of vertical curves.

Grates shall be certified by the manufacturer as bicycle friendly, and the certification shall be submitted to the City of Casper prior to installation.

4. Cover and frame seat shall be machine finished to prevent any rocking of cover in its associated frame. Cover shall have the word "storm sewer" clearly cast on its surface.

When required, self-sealing, waterproof frames and covers meeting Neenah R-1916-F, D &L E-1043, or approved equal shall be used.

5. Flared end sections for culverts shall be manufactured of the same material as the culvert. End sections shall be fitted for a trash rack on both upstream and downstream ends, or as directed by the Engineer.

E. Granular Materials.

1. Granular materials furnished for foundation, bedding, encasement or other purposes as may be specified, shall consist of any material or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone or slag, that shall be so graded as to meet the gradation requirements specified herein for each particular use.

2. Granular materials furnished for use in foundation, bedding, or encasement recommended for use in construction are:

Sieve Size	MATERIAL USE DESIGNATION	
	Percent Passing	
	Foundation	Bedding and Encasement
1 inch (25mm)	100	100
¾ inch (20mm)	85-100	90-100
3/8 inch (9.5mm)	30-60	50-100
No. 4 (4.75mm)	0-10	35-100
No. 200 (0.075mm)		0-10

3. Other approved material for bedding and encasement shall consist of sand, sandy gravel, or fine gravel having a maximum size of three-quarter inch (3/4") (20mm), uniformly graded and a maximum plasticity of 6 as determined by AASHO T-89 and T-90. Other gradations may be used if written approval is obtained from the City.
4. Certified copies of all sieve analysis and plasticity analysis for the above materials shall be submitted to the City Engineer and approved before construction starts. Other sieve or plasticity analysis may be required during construction as directed by the City Engineer.
5. Granular materials provided for Foundation, Bedding, or Encasement use, shall be classified as to use in accordance with the following:
 - a. Granular Foundation: placed below and to the midpoint of the pipe as replacement for unsuitable or unstable soils, to achieve better foundation support.
 - b. Granular Bedding: placed from four inches (4") (100mm) below the pipe to the pipe midpoint, to facilitate proper shaping and achieve uniform pipe support. When foundation material is required, the granular bedding shall be of foundation material gradation.
 - c. Granular Encasement: placed below an elevation one foot (1') (300mm) above the top of pipe, after pipe installation, for protection of the pipe and to assure proper filling of voids or thorough consolidation of backfill.
6. Granular encasement and bedding material shall meet the gradation requirements listed in Section 602.03.E.2. Other gradations may be used if written approval is obtained from the City Engineer. Gradations should meet the requirements of ASTM 2321. Guidelines for the maximum particle size for encasement material in relation to pipe type and diameter are shown below:

<u>Pipe Type</u>	<u>Nominal Diameter Inches (mm)</u>	<u>Maximum Particle Size Inches (mm)</u>
PVC, Other Plastic	15" and greater	3/4 (20)
PVC, Other Plastic	Less than 15"	1/2 (12.5)
Concrete	6.1 - 12.0 (155 - 300)	1 (25)
Concrete	12.1 (307) and greater	1 (25)
CMP	6.1 - 12.0 (155 - 300)	1 (25)
CMP	12.1 (307) and greater	1 (25)

7. Select Backfill

Job excavated and imported select backfill material shall be free from debris, organic material, and stones larger than three inches (3") (75mm) in diameter. Contractor shall be responsible, at his expense, for separating debris, organic material and stones larger than three inches (3") (75mm) in diameter. Select material that the Engineer directs to be used shall be the same gradation as the bedding and encasement material. No asphalt chunks or concrete may be used as select backfill.

8. Structural Fill Material

Structural fill shall consist of excavated or imported material, free of organic or deleterious material and particles larger than three inches (3") (75mm) in maximum dimension. Structural fill shall be well graded from coarse gravel to fine sand with less than 10% passing the No. 200 sieve. Structural fill material shall be within +2% of optimum moisture content when placed as determined by Proctor, and shall not exhibit pumping (horizontal or vertical displacement) after completion.

9. Groundwater Barriers

Low permeability ground water barriers shall be used in areas designated by the City Engineer. Barrier material shall meet soil classification GC, SC, or CL per the Unified Soil Classification System and shall have a liquid limit less than 50. The barrier material shall be compacted to 95 percent of maximum density. Job excavated material meeting one of the above soil classifications and free from stones, organic matter and debris may be used.

602.04 Execution.

A. Excavation for Pipe and Related Structures (General).

1. Complete all excavation regardless of the material encountered. If structures, utilities, or other objects are encountered that may be necessary for continued facility operation or may need preservation, immediately notify the Engineer and protect said object.

2. When cutting into existing roads, streets, alleys, or other public rights-of-way, the Contractor, shall obtain the proper licenses, cut permits, etc., from the appropriate authority.
 - a. Where trench excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a concrete saw, or similar approved equipment to obtain a straight, square, clean break. Cuts shall be located at standard joint locations, when possible.
3. When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces, the Contractor shall strip the cover material to full depth of the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose. New material shall be provided as necessary. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of twelve inches (12") (300mm), whichever is less.
4. The disturbed area from construction shall be confined within the construction limits.
 - a. The trench shall be dug only as far in advance of the pipeline as work can be reasonably completed that day. The sides of the trench shall be sloped and/or braced in accordance with the current OSHA Standards and the trench drained so that workers can work safely and efficiently. It is essential that the discharge of pumps when required, be laid to approved natural drainage channels or storm sewers. Wyoming State Engineer groundwater permits and Department of Environmental Quality discharge permits shall be required for dewatering.
5. Pipe crossings under sidewalks or curbs may be made by tunneling only if approved by the Engineer. If the Contractor elects to remove a portion of the sidewalk or curb, he must use a concrete saw for making neat joints corresponding to existing joints, compact the backfill as specified, and pour a new concrete sidewalk or curb section in accordance with the applicable sections of these specifications.
6. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials shall be stored and retained at least two feet (2') (600mm) or more from the edge of the trench in accordance with Wyoming Occupational Health and Safety Rules and Regulations for Construction, Chapter XVI, Section 2.i.(1). Excavated material must not be piled over nearby existing parallel trench lines unless adequate precautions are taken by the Contractor to prevent sidewall failure. Ready access to existing fire alarm boxes, fire hydrants, valves, manholes, and other appurtenances must be maintained.

- a. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils, which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.
 - b. All excavated material shall be piled within the construction limits or in a location obtained by the Contractor and accepted by the Engineer in a manner that will not endanger the work and that will avoid obstructing sidewalks, driveways, and fire hydrants.
7. Surface drainage of adjoining areas shall be unobstructed. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in unbackfilled trenches until after the pipe has been placed, tested, and covered with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be reinstalled.
 - a. Gutters shall be kept clear or other satisfactory provisions made for street drainage at all times.
8. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings. Bedding material shall be added (four inches (4")) (100mm) minimum) to provide uniform bearing and support for each section of pipe at every point along its length. Care must be taken to avoid over excavation. Unauthorized over-depths shall be backfilled with approved bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to the satisfaction of the City Engineer. The finished trench bedding beneath the pipe shall be prepared accurately by means of hand tools.
 - a. The bottom of all excavations shall be neat and clean, containing no abrupt changes in grade except as shown and shall be free from all slough. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material by compacting soil material to at least 95% Standard Proctor, ASTM D698.
 - b. If in its natural state the material at the bottom of the trench is soft and, in the opinion of the City Engineer, cannot support the pipe, a further depth and/or width shall be excavated as directed by the City Engineer and refilled with foundation material to the midpoint of the pipe. Other approved methods may be used to assure a firm foundation.
 - c. Foundation material used to dewater the trench or to replace a wet material shall be considered incidental to construction.
9. Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches (6") (150mm) below the outside barrel of pipe and allow a clear width

of six inches (6") (150mm) on each side of the pipe. The space between the bottom of the trench in bedrock or rocky areas and the bottom of the pipe shall be backfilled with suitable granular material in three-inch (3") (75mm) uncompacted layers and thoroughly tamped before pipe is installed.

10. Blasting the excavation to remove rock, clay, or hardpan will not proceed until the Contractor has notified the City Engineer of the necessity to do so and obtained written approval. This notification shall in no manner relieve the Contractor of the hazard and liability contingent on blasting operations. The City Engineer shall fix the hours of blasting. The Contractor at his expense shall repair any damage caused by blasting. The Contractor's methods of procedure relative to blasting shall conform to local and state laws and municipal ordinances, and the necessary permits shall be obtained.
11. The width of the trench shall be such to provide adequate working room for workers to install the pipe in the specified manner. The trench in the pipe zone and to one foot (1') (300mm) above the pipe zone shall be adequate in width to allow for proper compaction but shall in no case be wider than the pipe diameter plus three feet (3') (900mm).
12. Where the trench is not located near existing utilities, buildings, or other structures, and where water and other conditions permit, the Contractor may omit sheeting and bracing of the excavation. In this event, sides of the trench shall be sloped to protect the workers working within them in accordance with Wyoming Occupational Health and Safety Rules and Regulations for Construction. However, the trench must stay within the construction limits.
13. The Contractor shall provide safety boxes or sheeting and bracing necessary to confine his work within the construction limits, to provide safe working conditions, to prevent damage and delay to the work, and to prevent the disturbing or settlement of adjacent road surfaces, foundations, structures, utility lines or railroad tracks. The Contractor shall be responsible for the strength and sufficiency of all sheeting and bracing.
14. Any damage to the work under this contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins, or other reasons due to failure or lack of sheeting and bracing, or improper bracing, or through negligence or fault of the Contractor in any manner, shall be repaired by the Contractor without delay and at his expense.
15. Bracing shall be so arranged as to provide ample working space, so as not to interfere with the work, and so as not to place any strain on the structures being constructed, until such structures are of sufficient strength to withstand such strain. No sheeting and bracing shall be removed until the construction has proceeded far enough to provide ample strength for its safe removal.
 - a. Sheeting or bracing may be left in place in the trench at the discretion of the City Engineer. Any sheeting or bracing left in place shall be cut off approximately three

feet (3') (900mm) above the top of the pipe or two feet (2') (.6m) below finish grade, whichever is lower, and the cut-off portion removed. All sheeting or bracing left in place shall be accurately located and shown on the "Record Drawings" (See Sec. 602.115 of these specifications).

16. The Contractor shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, shoring, and blasting operations to conform to OSHA regulations.

B. PCE Testing Requirements

1. Where groundwater contamination is known or suspected, the Contractor shall provide PCE air and water testing services. These services will be required on all excavations where dewatering activities are required and where PCE groundwater contamination is known or suspected. The Contractor shall provide said testing as performed by a certified testing laboratory, and by certified testing methods, and subject to approval of Engineer and City.
2. The Contractor shall provide testing services for the following air and groundwater contamination sampling requirements. All results shall be submitted to Engineer and City.
 - a. Air Sampling. One instantaneous test per fifty feet (50') (16m) of trench shall be taken as the excavation progresses. Results are to be obtained by detector tube test or Organic Vapor Analyzer, or other similar device. These devices must be capable of detecting air quality parameters within the maximum time weighted average (TWA) detection limits for an eight (8) hour period as set by OSHA.
 - b. Should air sampling test results yield concentrations higher than those set by Wyoming Occupational Health and Safety Commission, contractor is to immediately notify the Engineer, Owner, City, and DEQ and take the appropriate precautions to inform and protect workers and the public from the contaminant. There are several possible methods for protecting against the contamination some of which include natural trench ventilation, mechanical ventilation, protective clothing and breathing apparatus for workers and combinations of the above. These protective actions shall be the sole responsibility of the Contractor and he shall use workers, equipment, and methods approved by OSHA for the types of soil contaminants encountered.
 - c. One (1) groundwater PCE contamination analysis shall be taken per stationary excavation site, and two tests per pipeline, same as above. Detection limits for water testing shall be 0.50 micrograms per liter (ppb).
 - d. Should water sampling test results yield concentrations higher than those set forth by the EPA Manual Guidance of the Undevelopment and Implementation of Local

Discharge Limitations Under the Pretreatment Program, Dec. 1987, the contractor is immediately to notify the Engineer, Owner, and DEQ to help coordinate a course of action.

C. Volatile Organic Compound Sampling

1. For those sites with known or suspected soil contamination, the contractor shall provide for ongoing volatile organic compound (VOC) monitoring of the air (similar to that described for PCE air monitoring) in the breathing zone of the trench and associated working areas. Monitoring shall be performed using an organic vapor analyzer (OVA) or other similar device capable of detecting air quality parameters within the maximum time weighted average detection limits for an eight-hour period as set by OSHA. All VOC monitoring shall be performed by a trained and competent environmental testing service, subject to prior approval of the Engineer, City, and Owner.
2. If and when the VOC level for any breathing zone test exceeds 5.0 milligrams per liter (ppm), the contractor shall immediately notify the Engineer, Owner, City and DEQ and take the appropriate precautions to inform and protect workers and the public from the contaminant. There are several possible methods for protecting against the contamination some of which include natural trench ventilation, mechanical ventilation, protective clothing and breathing apparatus for workers and combinations of the above. These protective actions shall be the sole responsibility of the contractor and he shall use workers, equipment, and methods approved by OSHA for the types of soil contaminants encountered.
3. The necessary ventilation and protective equipment will be expected to be readily available when the need arises, if VOC (and PCE) contamination is encountered. The cost of any interruptions or reduction in work efficiency resulting from VOC contaminated soils (and PCE) shall be born solely by the Contractor.

D. Dewatering, if required by site conditions, shall be provided by the Contractor. The contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.

1. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12") (300mm) or more below the bottom of the excavation.
2. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

3. The Contractor shall be responsible for the conditions of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
4. In areas where dewatering is required, the Contractor will comply with the following requirements.
 - a. All discharges from dewatering systems, including well points, dewatering wells, pumps in the bottoms of the trenches, etc. will require a permit from the Wyoming Department of Environmental Quality (DEQ). Before starting any construction, the Contractor shall submit an application to discharge to the DEQ along with this proposed dewatering plan for review. The application shall be submitted on “National Pollutant Discharge Elimination System, Application to Discharge from a Construction Project, Short Form E”. If the dewatering plan is revised during construction, a revised plan will be immediately sent to the DEQ by Contractor.
 - b. If there is any evidence of hydrocarbon or other contamination of the discharge water the discharge shall immediately cease and the DEQ shall be notified immediately. The Contractor will then comply with DEQ conditions.
 - c. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineering office with the application for an excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineering office.

F. Disposal of Excess Material

1. Except as otherwise permitted, dispose of excess excavated materials in a legal manner.
2. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.

602.05 Pipe Installation

- A. The Contractor shall use laser beam equipment, surveying instruments, or other proven techniques to maintain accurate alignment and grade. Reasonable care shall be exercised in handling and laying the pipe and fittings. The interior of all pipe and fitting shall be kept

free from dirt and foreign matter at all times, and cleaned out thoroughly before being lowered into the trench. Under no circumstances shall materials be dropped or thrown into the trench.

- B. Materials shall be placed where they will not be subject to injury from vehicles or equipment. The contractor's facilities for lowering the pipe into the trench shall be such that neither the pipe nor trench will be damaged or disturbed. Pipe shall be lowered into the trench with rope slings, gin poles, dragline, or trench in such manner as to lay the pipe carefully into place and shall be lowered and laid with the bell end upgrade. Holes shall be dug under the bells so that pipe is unsupported at the pipe connection. The laying of pipe in the finished trench shall be started at the lowest point and laid upgrade. The Contractor shall clean and remove all sand, gravel, concrete, and cement grout that has entered the lines in the process of construction.
- C. Any pipe which is broken, cracked, or otherwise unsuitable, as determined by the Engineer, shall be removed and replaced by the contractor at no additional cost to the owner. Any damage to pipe coatings shall be repaired with the same materials used for the original coating before laying the pipe.
- D. The Contractor shall keep the pipe, manholes, catch basins, and other structures free from deposits of mud, sand, gravel, or other foreign matter, and in good working condition until the construction is completed and accepted. Upon completion of each line between manholes, a clear and unobstructed view of the whole bore of a pipe shall be obtained between manholes by use of a light or subreflector. If such view is not apparent an air-filled rubber ball, approved by the Engineer, having a diameter one-inch (1") (25mm) less than the tile to be tested, shall be flushed through the line between manholes. Any obstruction found in any line shall be removed by the contractor without cost to the owner. Any methods used by the contractor to remove deposits of mud, sand, gravel, or other foreign matter from the line shall be approved by the Engineer. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels or bells, etc.) will not be allowed.
- E. Pipe shall not be laid on frozen ground, or when trench conditions are unsuitable for such work.
- F. The upgrade end of pipelines not terminating in a structure shall be plugged with a cap or plug approved by the Engineer.
- G. Fine grading to the bottom of the barrel shall proceed ahead of the pipe laying and, should any over-excavation exceeding two inches (2") (50mm) be encountered, the material added shall be moistened (95% of Standard Proctor) and compacted to the density of the existing subgrade or foundation material shall be added at the Contractor's expense.

- H. Bell holes shall be dug for the pipe bells or couplings and the materials placed along the preceding pipe laid. The pipe shall be supported for the bottom 60 degrees and throughout its length (except for the minimum distance necessary at the bell holes). Bell holes shall be adequate to make the joint, but no larger than necessary so that maximum support on undisturbed ground or pipe zone material will be provided for the pipe. The remainder of the pipe shall be surrounded to at least its midpoint by granular bedding material, compacted in maximum six inch (6") (150MM) layers to completely fill all space under and adjacent to pipe.
- I. Pipe laying should proceed upgrade with the spigot ends pointed in the direction of flow. No pipe shall be laid in water or when the trench conditions are unsuitable for such work, except by written permission of the Engineer. The Contractor shall make all connections of pipe to the manholes which have previously been constructed.
- J. The Contractor shall connect all existing storm inlets and sewers to the new storm sewer as shown on the drawings. These connections shall be made as the storm sewer construction progresses which will require that each section of the new sewer be fully completed and ready for operation as the construction advances.
1. Open excavation shall be satisfactorily protected at all times. At the end of each day's work, the open ends of all pipes shall be protected against the entrance of animals, children, earth, or debris, by bulkheads or stoppers. The bulkheads or stoppers shall be perforated to allow passage of water into the installed pipeline to prevent flotation of the pipeline. Any earth or other material that may find entrance into the main sewer or into any lateral sewer through any such open end of unplugged branch must be removed at the Contractor's expense.
- K. Installation for pipelines using flow fill shall be as follows:
1. The mix design for flow fill shall meet the requirements of Division 200, Section 205.05, Control Density backfill mixture requirements.
 2. Assembly must be done under dry conditions with all joints completely cleaned of dirt and contaminants. Pipe ends and joints shall be kept covered until connection with next pipe segment or fitting. All joints shall be lubricated in accordance with the manufacturer's recommendations and assembled by pushing the spigot into the bell until the reference mark on the pipe barrel is flush with the end of the bell.
 3. The pipe to be embedded in flow-fill can be laid on a four- to six- inch (4"– 6") (100 – 150 mm) bed of washed gravel that has been excavated for the bells so that the pipe is uniformly supported along its entire length, or the pipe can be set on four inch (4") (100mm) high blocks spaced no further than every ten feet (10') (3m). The flow-fill or washed gravel must bear on undisturbed trench bottom. If necessary, Contractor shall stake the pipe to prevent lateral movement or floating during the placement of the flow-fill. The flow-fill must be placed carefully under and around the pipe and

extend from undisturbed trench sidewall to sidewall. Placement may be by chute, bucket, or other means to assure that the line and grade of the pipe or pipes is maintained. The flow-fill must extend to at least two inches (2") (50mm) above the top of the pipe.

L. Installation for pipeline crossings using flow fill shall be as follows:

1. Whenever possible, the pipes should be laid so there are no joints or taps within nine feet (9') (2.7m) of the crossing. The flow-fill shall extend from undisturbed earth at the bottom of the lower pipe to at least two inches (2") (50mm) above the top of the upper pipe and extend from one side of the trench to the other. Pipes crossing one another can be separated by as little as four inches (4") (100mm) when embedded in flow-fill. The flow of flow-fill must be wide enough to ensure the structural integrity of the installation. All sewer services crossing over water mains must be encased in flow-fill in accordance with the provisions of this specification.
2. All sewer services crossing over water mains must be encased in flow-fill in accordance with the provisions of the above specifications.
3. There shall also be a concrete flow-fill barrier between City lines and high pressure petroleum lines.

602.055 Installation of Manholes

- A. Excavation shall be to a depth and size to provide for construction of the manhole. Concrete bases shall be poured on undisturbed ground. Precast concrete bases shall be carefully lowered onto one of the following:
 1. Six inches (6") (150mm) minimum layer of well-compacted granular material accurately laid to a smooth level surface using a straight edge and hand level.
 2. Three inches (3") (75 mm) of concrete poured on undisturbed soil.
- B. Walls shall be of precast concrete as shown in the standard drawings and shall be constructed to form a complete watertight structure.
- C. The Contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two-inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight in accordance to Drawing 602-2. Wood will not be allowed as spacers. Adjusting rings shall conform to the size and shape of the casting frame. Frames and covers shall be set to the designated elevation in a full mortar bed.

1. The minimum two-inch (2") (50 mm) concrete ring for grade is not needed if grade can be met with a six-inch (6") (150mm) flange on top of the cone section of the manhole.
 2. If the number of adjusting rings exceeds the maximum twelve inches (12") (300 mm), the manhole shall be reexcavated and a manhole barrel section installed.
- D. Manholes shall be set as shown on drawing 601/5 and 601/2. All lifting holes must be grouted in after placement.
- E. When manholes are to be constructed in new streets, manhole rings shall be set to the final grade before the street-wearing course is placed. Riser rings shall not be used to make adjustments for new construction. In gravel or unpaved roads, the manhole ring shall be kept four to six inches (4"-6") (100mm-150mm) below the road surface.
- F. The invert of all manholes shall be smoothly shaped so as to allow a free, uninterrupted flow of storm water. The invert forming system shall be "A-Lok Tru Contour", or approved equal.
1. Floor troughs shall be furnished for all storm sewers entering manholes. Inverts shall be U-shaped to the 1.0 diameter point before sloping at a 1 to 12 slope to the manhole walls.

602.06 Trench Backfilling.

- A. All excavation in trenches shall be backfilled to the original ground surface or to such grades as specified or as shown on the drawings. The backfill shall begin as soon as practical after the pipe has been placed and shall thereafter be carried on as rapidly as the protection of the balance of the work shall permit.
1. No pipe shall be covered before the Project Representative or the Engineer has observed and approved the pipe. If any piping or appurtenance is covered without the approval of the Engineer or Resident Project Representative, at the discretion of the Engineer, the Contractor shall be required to re-excavate to expose the covered materials. The cost of exposing those materials and then backfilling and recompacting will be at the Contractor's expense regardless of the condition of the pipe and/or the materials under question.
 2. The Contractor shall completely backfill all excavations before stopping work at the end each day. Open excavations (fenced or unfenced) shall not be allowed overnight or on weekends at any site after work has stopped for the day unless approved by the City.

- B. Complete cleanup shall proceed directly behind the backfilling operation to accommodate the return to normal conditions. Should the Contractor, in the City's opinion, fail to pursue diligently the backfilling and cleanup, the amount of work on which complete cleanup has not been accomplished shall be limited to one thousand lineal feet (1,000') (300m) for the entire job. The Contractor shall have sufficient equipment on the job to assure timely backfill and cleanup at all times.
- C. Bedding Material. Bedding material shall be placed as shown on the typical trench detail. Spread and surface grade bedding material to provide continuous and uniform support beneath pipe at all points between bell holes or pipe joints. Particular attention shall be given to the area from the base of the pipe or culvert to the centerline to ensure firm, uniform, and continuous support is obtained and to prevent any lateral movement upon subsequent backfilling or under service conditions. Bedding material shall be placed, prepared, and compacted simultaneously on both sides and lateral movement shall be prevented. Bedding material shall be moisture conditioned to +2% to -4% of optimum and compacted to 90% maximum density, as determined by ASTM D698. Pipe zone material shall be placed manually with shovels, and tamped in maximum 6" lifts and evenly placing the material on both sides of the pipe. Material shall not be dropped directly onto pipes or culverts when using loaders or backhoes. Bedding material shall not exhibit pumping (horizontal or vertical displacement) after compaction. Encasement material will then be placed around and over the top of the pipe, but need not be hand placed.
- D. Trench Backfill above the Encasement Zone. Trench backfill above the encasement zone may consist of excavated material or select backfill material. Excavated material shall be used unless its gradation does not meet the requirements of select backfill material. Backfill material shall be pushed onto the slope of the excavated trench and allowed to slide down into the trench. Backfill material shall not be permitted to free fall into the trench until at least two feet (2') (600mm) of cover is over the pipe or culvert. Moisture conditioning may be provided by water trucks or hoses. Excavated or select backfill material shall not exhibit pumping (horizontal or vertical displacement) after compaction.
- E. Backfilling shall be done in lifts of uniform layers which will produce the required compaction. Each lift shall be completely compacted over the full width of the excavated area. Compacting shall continue until the specified relative compaction has been attained or until no more settlement occurs. Water jetting of backfill shall not be permitted.
- F. Groundwater barriers shall be placed at maximum three hundred feet (300') (90m) intervals or where directed by the Engineer. These shall be provided to interrupt the passage of water through the foundation, bedding, encasement, and select backfill material. The barriers shall be compacted to 95% of maximum density (Standard Proctor) the full depth of the granular material, the full trench width and a minimum of three feet (3') (900mm) long.
- G. In-place densities of compacted backfill material shall be determined by the Engineer using either ASTM standard test method D1556-82 (Sandcone) or ASTM standard test method

D2922-81 (nuclear). The minimum and maximum dry density for non-cohesive materials such as clean sands and gravel shall be determined by ASTM D4253 and D4254. The maximum dry density for cohesive backfill materials, such as clays, silts, etc., shall be determined by ASTM D698.

1. Backfill above the encasement zone shall be compacted to the minimum densities and moisture conditions listed below. The densities listed below may only be modified through a geotechnical report.

<u>Area</u>	<u>Cohesive</u>
Streets, highway, alleys	95%, $\pm 2\%$
Sidewalks, curbs, and driveway	95%, $\pm 2\%$
Lawns and cultivated areas	90%, $\pm 2\%$

- H. Care of Utilities. In excavating and backfilling for pipelines or structures, extreme care must be taken so as to not mar or injure any gas, telephone, sewer, water, power, or television lines. The utility owner shall be notified that the relocation is necessary and shall be given adequate time to provide for the relocation. See Division 100, Section 101.06 for more detail on utility locates.
- I. When the trench excavation for the sewer main and appurtenances is within the rights-of way of state or county highways, the backfilling of the trench, compaction of materials, subgrade preparation and surfacing shall be done in strict accordance with the requirements and specifications of the authority having jurisdiction or as required by these specifications, whichever is more stringent.
- J. In all cases, the Contractor shall blade and compact the roadway after the trench has been backfilled, so that it shall be passable to traffic at all times. The Contractor shall maintain the roadway in a condition acceptable to the City at all times until final acceptance of the entire work by the City.
- K. The Contractor shall also blade and maintain all detours and bypasses. All maintenance work shall be done at no additional compensation. In addition to the blading and maintenance requirements specified, the Contractor shall provide at least one tank truck with pressurized spray bars for spraying water on the streets to control the dust. Dust control shall be required as necessary on all streets after compacting and grading and on all detours and bypasses.
- L. The Contractor is responsible for the complete maintenance of his work at all times. If he fails to provide proper maintenance, and safety or nuisance conditions arise, it is expressly understood that City crews may be directed by the City to provide essential maintenance, and that such work will be done at the expense of the Contractor.

- M. The Contractor shall remedy at his own expense any defects that appear in the backfill following completion and during the warranty period.

602.07 Installation of Structures.

- A. Structures shall be set on a six-inch (6") (150mm) layer of foundation material when directed by the Engineer. The surface shall be accurately graded to provide uniform bearing for the structure.
- B. Catch basins shall be constructed at the locations shown on the drawings and approved by the Engineer. The size and type of catch basins shall be shown on the drawings or in the Standard Details of the Specifications. Catch basin frames shall be set accurately to grade. Concrete grout shall then be placed around and beneath the frame to hold the grate securely in place.
- C. Manhole castings shall be installed one-fourth inch (1/4") (6.25mm) to one-half inch (1/2") (12.5mm) below the surface of the existing pavement. Where the structure is in unpaved streets, the manhole casting shall be set to the future street elevation. The casting shall be constructed as shown in the Standard Details. The contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight. The bearing surface around the perimeter of the frame shall be grouted to a height within two inches (2") (50mm) from the existing street surface, and to a width of twelve inches (12") (300mm) greater than the manhole ring, and a depth of six inches (6") (150mm) below the bottom adjusting rings or one foot (1') (300MM), whichever is greater. The manhole frame shall then be tacked and asphaltic concrete pavement shall be placed for the final two inches (2") (50mm).

602.08 Structure Backfilling.

- A. Structure backfilling shall cover manholes, catch basins, junction boxes, and any other structure encountered during the course of the work. Fill around structures shall consist of trench backfill meeting the requirements of structural fill material or select backfill material. Fill material shall be spread and compacted to provide continuous and uniform support around the structure. Special attention shall be given to the compaction operation around structures to ensure uniform compaction.
- B. Do not place fill when the surface to be filled is snow covered or frozen. Do not place frozen fill.
- C. Fill around concrete structures shall commence only after concrete has attained 80% of the ultimate compressive strength specified. Remove all form materials, concrete spills, and

trash from around the structures before placing fill. Where backfilling on both sides or around the perimeter of a structure is required, place the backfill and compact simultaneously at the same elevation on opposite sides or around the perimeter in lifts.

- D. Place fill material in eight inch (8") (200mm) maximum lifts and compact to at least 95% density for cohesive soils. The moisture content shall be +2% to -2% of optimum.

602.09 Cleanup.

- A. Construction cleanup and all backfill operations shall directly follow the storm sewer installation. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc.
- B. During construction, all existing gutters, storm drains, runoff channels, etc., shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.
 - 1. See Division 100, Section 101 for additional cleanup requirements.

602.10 Quality Control.

- A. Light Test. After the trench has been backfilled, a light test shall be made between manholes to check alignment and grade for displacement of pipe. Except for curved alignments shown on the plans, the completed pipeline shall be such that a true circle of light can be seen from one manhole to the next. If alignment or grade is other than specified and displacement of pipe is found, the Contractor shall remedy such defects at his own expense.
- B. Leakage Test. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels, or bells, etc.) will not be allowed.
- C. Gradation Test.
 - 1. Bedding Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd³) (750m³) placed of each material.
 - 2. Foundation Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd³) (750m³) placed of each material.
 - 3. Structural Fill Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd³) (750m³) placed of each material.

4. Select Backfill Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd³) (750m³) placed of each material.
5. Encasement Backfill Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd³) (750m³) placed of each material.
6. All gradation tests shall be the responsibility of the Contractor using a certified approved testing laboratory acceptable to the Owner and Engineer. The Contractor shall be responsible for all costs associated with gradation testing.

D. Density Test.

1. Encasement Zone Material. One test for each five hundred lineal feet (500') (150m) pipe installed.
2. Bedding Zone Material. One test for each five hundred lineal feet (500') (150m) pipe installed.
3. Trench, Select Backfill Material, and/or Structural Fill Material. One standard proctor test ASTM D698 or one relative density test, (ASTM D4253 and D4254) for each type of material for every two foot (2') (600mm) of trench depth above the pipe zone per every one hundred lineal feet (100') (30m) pipe installed. The Engineer may elect to take one test for each one thousand cubic yards (1000yd³) (750m³) or a portion thereof.
4. Unless otherwise indicated in the Contract Documents, density and moisture tests shall be the responsibility of the Owner/Engineer. The Contractor shall cooperate with the Engineer or testing agency. If the initial moisture/density tests fail, the Contractor will be responsible for all costs associated with retests, until a passing moisture/density test is completed.

E. Deflection Test – Mandrel testing for flexible conduit may be determined by the Engineer.

602.105 Final Acceptance and Record Drawings.

- A. "Record Drawings" shall be submitted to the City prior to preliminary acceptance of the construction project. "Record Drawings" shall include, in addition to construction drawings and details, "as built" information where it differs from construction drawings and locate information including horizontal and vertical coordinates in the datum established by the City for the Geographical Information System.

B. Final Acceptance

1. Final acceptance will not take place until preliminary acceptance is obtained and all paving and curbside is completed.
2. Before final acceptance of any sanitary sewer, the following inspections shall be made:
 - a. All lines clean and flushed
 - b. Manholes up to proper grade in a proper condition
3. All punch list items must be completed prior to final acceptance.
4. The warranty period shall not start until final acceptance is obtained and a complete set of "Record Drawings" is submitted to the City.

602.11 Standard Detail Sections

602/1 Typical Street Cut Section Asphalt Surfacing

602/2 Standard Manhole Frame and Cover Grade Adjustment Detail

602/3 Standard Straight Manhole for Depths of 6'0" or Less

602/4 Standard Catch Basin Detail

602/5 Standard Storm Sewer Manhole Detail for Manhole Depth \geq 6' Invert to Rim

602/6 Standard Trash Guard Detail

DIVISION 620

SECTION 621

GEOTEXTILES FABRICS AND MEMBRANES

621.01 Description

This section covers furnishing and placing geotextile as shown on the plans or directed, in accordance with these specifications. The geotextile usage will determine the applicable specifications and the corresponding pay item.

621.02 Materials

The geotextile shall consist only of woven or non-woven, long-chain polymeric filaments or yarns such as polyethylene, polyester, polyamide, or polyvinylidene chloride formed into a stable network such that the filaments or yarns retain their relative positions to each other. The geotextile shall conform to the requirements of section 620, as applicable for the specified use.

621.03 Equipment

Equipment loads when placing and compacting the material placed over the geotextile shall comply with the following:

- a. Maximum wheel load shall be 9,945 pounds (4500 kg), or as specified.
- b. Maximum contact pressure shall be 60 psi (400kPa). The contact pressure is calculated from the applied wheel load in newtons and the resulting contact area in square meters.
- c. Rutting in excess of three inches (3") (75mm) will not be allowed. Equipment loads are to be lightened if this occurs. Ruts shall be repaired by filling the ruts with additional material.

621.04 Construction Requirements.

The geotextile shall be lapped a minimum of two feet (2') (0.6m) at ends and sides of adjoining sheets unless shown otherwise on the plans. Geotextile that is joined by sewing shall have strength properties at the seam equal to the specified strength requirements of the geotextile. All seams shall be exposed for ease of inspection. High-strength polyester, polypropylene or kevlar thread shall be used for sewn seams. Nylon threads shall not be used. Overlapping J seams and double sewing are required for field seams. The requirements for overlapping of seams shall be two feet (2') (0.6m) minimum or as specified on the plans.

Gravel, base course, sand, or other specified material shall be placed on the geotextile so that it is not torn, punctured, or shifted. Maximum pile heights of materials shall be limited to prevent geotextile distortion. Any geotextile that is torn or punctured shall be repaired. The repair shall

consist of a patch of the same type of geotextile placed over the ruptured area and overlapped a minimum of three feet (3') (1m) from the edge of any part of the rupture, or a sewn patch with the same requirements for seam strength as that of the geotextile being repaired.

Pegs or pins, as approved by the Engineer, may be used to hold the geotextile for embankment erosion control in place until the specified cover material has been placed. Pegs or pins shall not be used for other types of geotextile installations without approval of the Engineer. If such approval is given, pegs or pins shall be used only at locations that are not detrimental to the finished product.

When geotextile is used for foundation stabilization, the following criteria shall govern:

- a. The cover material shall be placed over the geotextile in 1-foot (0.3m)+/- lifts.
- b. Equipment shall not be operated directly on the geotextile. The minimum left thickness shall be maintained at all times.
- c. The cover material shall be compacted with a roller or other equipment as approved by the Engineer.
- d. Prior to the installation of geotextile, the subgrade shall be leveled and smoothed to remove ruts, depressions, or humps, which exceed four inches (4") (100mm). The surface also shall be free of rocks, stumps, roots, brush, limbs, or other objects that might tear or puncture the geotextile or result in geotextile wear.

During periods of shipment and storage, the geotextile shall be enclosed in heavy duty wrapping to protect it from direct sunlight, ultraviolet rays, temperatures greater than 140°F (60°C), mud, dirt, dust, and debris. Any geotextile left unprotected shall be removed from the project.

The product name, type of material and the lot or batch identification shall be clearly labeled on each roll.

Except for geotextile used for erosion control and silt fence, the cover material shall be placed over the fabric within five (5) days.

Test results, with a certification by the manufacturer showing the geotextile performance in regard to the material requirements of this specification, shall be submitted to the Engineer. At least two weeks before the use of any geotextile, a sample six feet (6') (2 m) in length by the full width of the roll shall be submitted to the Engineer. The sample shall be labeled with the product name, machine direction, the lot and batch number, date of sampling, project number, and certification of compliance with the material specifications. If sewing is specified, a seam sample also shall be submitted to the Engineer. The sample sewn section shall be six feet (6') (2 m) by three feet (3') (1 m) with the seam in the center and parallel to the six feet (6') (2 m) length.

621.05 Method of Measurement.

The Engineer will measure Geotextile by the square yard of surface area covered. No measurement will be made for overlaps. Pins, pegs, sewn seams, or other items necessary for the placement of the geotextile will be subsidiary to the pay item.

DIVISION 620

SECTION 622

IMPERMEABLE PLASTIC MEMBRANE

622.01 Description.

This section covers furnishing and placing impermeable plastic membrane in accordance with these specifications and as shown on the plans or as specified by the Engineer.

622.02 Materials.

The membrane shall be woven or non-woven polypropylene or polyethylene geotextile with a bonded polypropylene or polyethylene film and shall conform to the requirements as specified in this section or as directed by the Engineer.

If a cushion is required, it shall conform to the material requirements shown on the plans. The moisture content shall be optimal for compaction. The cushion shall be crushed base course. A sand cushion can only be placed with written approval by the Engineer.

622.03 Equipment.

Equipment loads, when placing and compacting the material placed over the geotextile, shall be adequate to perform the work without damaging the fabric or the application for which it was designed.

622.04 Construction Requirements.

The foundation for the membrane shall be smooth and free of pockets, loose rocks, or any other material that could damage the membrane.

Longitudinal and lateral joints shall be overlapped a minimum of six inches (6") (150 mm) and glued with a product that conforms to the membrane manufacturer's recommendations for product type, application rate, and curing procedures. If glued joints are not utilized, the membrane shall be overlapped a minimum of two feet (2') (0.6m). The overlaps shall be shingled so that the exposed edges face in the same direction as the flow of drainage. All blemishes, holes, or scars shall be reinforced and sealed with waterproof plastic adhesive tape. All unacceptable portions of the membrane, and all unacceptable sealed joints shall be replaced without additional payment.

Pegs or pins shall not be used to hold the membrane in place. Membrane that is damaged following installation as a result of the construction operations shall be replaced without additional payment.

During placement of the membrane, equipment may run directly on the membrane; however, no turning movements will be allowed. The membrane shall not be placed during rain or wet weather conditions or when the subgrade is wet.

When sharp or angular rock or aggregate will be in contact with the membrane, a sand cushion shall be provided between the membrane and the subgrade as called for on the plans. The sand cushion shall be a minimum of four inches (4") (100 mm) in thickness.

For vertical installation in trenches, the backfill material shall come from the trench excavation and shall be placed in a manner to prevent damage to the membrane. Backfill materials in direct contact with the membrane shall be free of large rocks, and shall be approved by the Engineer prior to backfilling. The trench shall be backfilled as soon as the membrane is in place. The backfill material shall be compacted and finished in accordance with the plans and specifications.

The cover material shall be placed over the membrane within five (5) days.

During periods of shipment and storage, the membrane rolls shall be enclosed in heavy-duty wrapping to protect the membrane from direct sunlight, ultraviolet rays, temperatures greater than 140 °F (60°C), mud, dirt, dust, and debris. Any membrane left unprotected shall be removed from the project.

The product name, type of material, and the lot or batch identification shall be clearly labeled on each roll.

Test results and a manufacturer's certification showing the membrane performance in regard to the material requirements of this specification shall be submitted to the Engineer. At least two weeks before the use of any membrane, a sample of the membrane six feet (6') (2m) in length by the full width of the roll shall be submitted to the Engineer. The sample shall be labeled with the product name, machine direction, the lot and batch number, date of sampling, project number, and certification of compliance with the material specifications.

622.05 Method of Measurement

The Engineer will measure impermeable plastic membrane in place by the square foot (m²) of surface area, including vertical surfaces in trenches, with no allowance for overlaps. The trench excavation and backfill, and the sand cushion will be incidental to the pay item, unless otherwise shown on the plans and contract documents.

DIVISION 620

SECTION 623

PAVING FABRIC

623.01 Description

This section describes furnishing and placing asphalt sealant and fabric as a stress relieving membrane within the pavement structure. This applies to fabric membranes used for full coverage of the pavement, or as strips over transverse and longitudinal pavement joints.

623.02 Materials

The asphalt cement shall meet the manufacturer's specifications and as directed by the Engineer. The paving fabric shall meet the requirements of this specification and as directed in the plans and specifications.

623.03 Equipment

The distributor shall meet the requirements as specified in 404.05. The distributor shall have a single nozzle hand spray with a positive shut-off valve.

Mechanical or manual laydown equipment shall be used for laying the fabric smoothly and evenly.

A pneumatic roller may be used if required.

623.04 Construction Requirements

Air and pavement temperature shall be 50° F (10°C) and rising. Only one paving fabric product shall be furnished for use on the project.

623.05 Fabric Storing

Fabric rolls shall be wrapped for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes.

Fabric rolls shall be stored and protected from the weather. If stored outdoors, the rolls shall be elevated and protected with a waterproof cover.

623.06 Surfacing Preparation.

The fabric shall be placed on a clean surface free of dirt, water, vegetation, and other debris.

623.07 Application of Asphalt Sealant.

The asphaltic sealant shall be uniformly applied to the prepared dry pavement surface at the rate and to the width indicated in the contract documents. Application of the asphaltic sealant shall be by distributor spray bar, with hand spraying kept to a minimum. For asphalt cements, the minimum application temperature shall be 290°F (140°C), and the distributor tank temperatures shall not exceed 325 °F (160°C).

The width of the asphaltic sealant application shall be the fabric width plus six inches (6") (150mm). The asphaltic sealant shall not be applied any farther in advance of the fabric placement than the distance that can be maintained free of traffic. Excess asphaltic sealant shall not be applied.

Asphalt spills shall be cleaned from the road surface to avoid flushing and fabric movement.

623.08 Fabric Placement.

The paving fabric shall be placed immediately in advance of the plant mix bituminous pavement so the paving fabric membrane is not exposed to traffic. Temporary traffic control, including flagging, shall be provided by and at no additional cost to the City of Casper to protect the fabric from exposure to traffic.

The fabric shall be placed into the asphaltic sealant with a minimum of wrinkling before the asphalt sealant has cooled and lost tackiness. Wrinkles or folds in excess of one inch (1") (25mm) shall be slit and laid flat.

Brooming shall be used to maximize fabric contact with the pavement surface. A pneumatic roller shall be used when ambient temperature is lower than 60° F (15°C) or the wind speed in greater than 20 mph (30 km/h).

Stiff bristle brooms or squeegees to smooth the fabric, scissors or blades to cut the fabric, and brushes for applying the asphalt sealant at fabric overlaps shall be provided.

Overlap of fabric joints shall be sufficient to ensure full closure of the joint and shall not exceed six inches (6") (150mm). Transverse joints shall be lapped in the direction of paving to prevent edge pickup by the paver. A second application of asphalt sealant to fabric overlaps will be required if additional asphaltic sealant is needed to ensure proper bonding of the double fabric layer. The City of Casper may require a representative of the fabric manufacturer to be on the project during the beginning of placement of the fabric.

Paving equipment and hauling units shall be operated so that braking, turning movements, and reversing direction of travel do not cause wrinkling, folding, or displacement of the fabric. Damaged fabric shall be replaced without additional payment.

Only emergency and construction traffic will be allowed on the fabric.

623.09 Hot Plant Mix Overlay

The temperature of the mix shall not exceed 325°F (160°C). In the event the asphalt bleeds through the fabric causing construction problems before the overlay is placed, the areas shall be blotted by spreading washed sand or hot mix.

623.10 Method of Measurement

The Engineer will measure paving fabric by the square yard (square meter) of surface area, complete, in place, with no allowance for overlaps. The fabric unit price will be full compensation for preparation of the application surface, application of asphalt cement, furnishing and placing the fabric, furnishing and placement of sand or broadcast hot-mix material, when required, and all labor, equipment, tools, and incidentals necessary to complete the fabric placement.

The Engineer will measure and document the asphalt cement (sealant) as provided for per the contract. The measurement will not include quantities of asphalt cement applied in excess of the application rate, as specified by manufacturer, or shown on the plans.

623.11 Paving Fabric

The fabric shall be non-woven, needle punched, with long-chain synthetic polymers composed of at least 85% polyolephins, polyesters, and polyamides by mass. The fabric shall be designed as a paving underseal fabric. The fabric shall be resistant to chemical attack, mildew, and rot. The fabric shall meet the following physical requirements:

Property	Test Method	Value
Nominal Mass	Texas DOT Test Method Tex-616-J	100 min.-200 max. g/m ² 4 oz/sq. yd.
Tensile Strength	ASTM D 5034 Grab Method G	400 min. N
	ASTM 4632-91	90-100 min.lbs.
Elongation at Break %	ASTM D 5034 Grab Method G	50 minimum
Asphalt Retention	Texas DOT Test Method Tex-616-J	900 min. ml/m ² 0.20 g/yds ²
Melting Point	ASTM D 276	142 min. °C
		150 – 300 °F

The minimum roll width shall be three meters (3 m) or twelve feet (12'). Notarized tests for samples taken for the lot(s) of fabric delivered to the project shall be submitted by the Contractor with the certification for the paving fabric. The number of samples taken for testing shall be in accordance with Procedure A of ASTM D 4354. A production lot shall be defined in ASTM D 4354 Section 6.1. A production unit is referred to in ASTM D 4354 Section 6.2.1. shall be an individual roll of fabric.

DIVISION 620

SECTION 624

MEMBRANE SPECIFICATIONS

624.01 Geotextile Membrane Requirements

GEOTEXTILE AND IMPERMEABLE PLASTIC MEMBRANE SPECIFICATIONS								
Geotextile and Membrane Requirements (*Minimum Roll Averages)								
Fabric and Membrane Property	Test Method	Drainage & Filtration	Erosion Control	Silt Fence	Separation & Stabilization		Embankment & Retaining Wall Reinforcement	Impermeable Plastic Membrane
					Woven	Non-Woven		

PERFORMANCE CRITERIA DURING SERVICE LIFE

Equivalent or Apparent Opening Size, US Standard Sieve (mm)	ASTM D4751	40-70 (0.425-0.212)	40-100 (0.425-0.150)	20-30 (0.850-0.600)	30-50 (0.600-0.300)	40-100 (0.425-0.150)	30-70 (0.600-0.212)	-----
Thickness, Mils (mm)	ASTM D 5199	-----	-----	-----	-----	-----	-----	12 (0.305)
Permittivity, Sec -1	ASTM D 4491	1.0	1.0	0.05	0.05	1.0	0.05	<10 ⁻⁷ cm/sec

GEOTEXTILE AND IMPERMEABLE PLASTIC MEMBRANE SPECIFICATIONS								
Geotextile and Membrane Requirements (*Minimum Roll Averages)								
Fabric and Membrane Property	Test Method	Drainage & Filtration	Erosion Control	Silt Fence	Separation & Stabilization		Embankment & Retaining Wall Reinforcement	Impermeable Plastic Membrane
					Woven	Non-Woven		

STRENGTH REQUIREMENTS

Grab Tensile Strength, lb. (N)	ASTM D 4632	90 (400)	180 (800)	100 (445)	200 (890)	160 (710)	300 (1335)	150 (665)
Elongation at Failure, %	ASTM D 4632	40 MIN	40 MIN	15 MIN	15 MIN	40 MIN	15 MIN	20 MIN
Trap Tear Strength, lb. (N)	ASTM D 4533	40 (175)	70 (310)	50 (220)	65 (300)	60 (270)	110 (500)	50 (220)
Puncture Strength, lb., (N)	ASTM D 4833	50 (220)	90 (400)	50 (220)	90 (400)	80 (335)	110 (500)	60 (265)
Seam Efficiency, %	ASTM D 4632	90%	90%	90%	90%	90%	90%	-----

624.02 Environmental Requirements

GEOTEXTILE AND IMPERMEABLE PLASTIC MEMBRANE SPECIFICATIONS						
Geotextile And Membrane Requirements (*Minimum Roll Averages)						
ENVIRONMENTAL REQUIREMENTS						
Ultraviolet Resistance, % Strength Retention	ASTM D 4355	50 % after 500 hrs. exposure	70% after 500 hrs. exposure	70% after 500 hrs. exposure	50 % after 500 hrs. exposure	50 % after 500 hrs. exposure
						50 % after 500 hrs. exposure

* Minimum Roll Average: All property values, with the exception of apparent opening size (AOS) represents minimum average roll values in the weakest principal direction (i.e., average test results of any roll in a lot sampled for conformance or quality assurance testing shall meet or exceed the minimum values provided. Values for AOS represent maximum average roll values.

DIVISION 600

SECTION 640

CHAIN LINK FENCE AND GATES

640.01 Description.

The work in this section covers the work necessary for the erection of chain link fence as shown on the drawings.

640.02 Materials:

- A. Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.
 - B. Submittals during construction shall be made in accordance with the general conditions. In addition, the following specific information shall be provided:

Shop drawings will be submitted for the engineer's review and approval prior to fabrication and delivery. These drawings shall provide detailed information and specifications for all materials, finishes, dimensions, and erection instructions.
 - C. Materials for chain link fencing shall be as follows. All steel or malleable iron parts and accessories shall be hot-dip galvanized.
1. Fabric: All chain-link fence fabric shall consist of woven wire in the form of approximately uniform square mesh, having parallel sides and horizontal and vertical diagonals of approximately uniform dimensions. 9 gauge, 2-inch mesh; galvanized ASTM A392, Class 1; knuckled selvage top and bottom.
 2. Posts: all posts shall be schedule 40 and hot-dip galvanized.
 - A) Line posts: 2-3/8" od pipe.
 - B) Terminal posts: 2-7/8" od pipe.
 - C) Gate or leaf posts between six feet (6') and thirteen feet (13') (7m) wide, 4-inch (4") (100mm) od pipe.
 - D) Top rail: 1-5/8" od pipe.
 3. Rail couplings: sleeve type, seven inches (7") (178mm) long.

4. Bracing: Pipe brace same as top rail, with 3/8-inch diameter steel rod truss and tightener.
5. Post tops: Prestressed steel, with hole for top rail, designed to fit over the outside of the posts and to prevent entry of moisture into tubular posts.
6. Fabric ties: Aluminum 9 gauge wires.
7. Tension wire: Galvanized or aluminum coated coil spring wire, 7 gauge.
8. Privacy slats: Fence slatting shall be extruded high density virgin polyethylene, containing color pigmentation and U.V. Inhibition to resist the effects of ultra violet radiation from sunlight and extend the colorfastness of the material for a minimum of ten (10) years without visible degradation. Contractor will provide the City of Casper with a 10-year manufacturer's warranty.
 - A. Slatting shall be manufactured by PDS Fence Products or approved equal.
 - B. Slatting shall be tubular shape, sized to match the application. Slatting shall have an integral locking system to securely anchor slats to the fence fabric.
 - C. Slat color shall be selected by owner, from manufacturer's standard colors.

640.03 Chain Link Swing Gates

Gates will be forty-two inches (42") (1m) wide for all pedestrian gates and twelve feet (12') (3.6m) wide for all maintenance needs all gates over forty-two inches (42") (1m) will be made up of two separate gates.

Gates shall be swing type, hinged to swing 180° from closed to open, complete with rams, hinges, fabric, latches, stops, supports, and keepers. Gate leaves shall have intermediate members and diagonal truss rods as required for rigid construction and shall be free from sag or twist. Joints between frame members shall be made by welding or by means of heavy fittings and shall be rigid and watertight. Truss rods shall be not less than 3/8" in diameter.

Gate fabric shall be same as fence fabric and shall be attached to frame ends by stretcher bars, bolt hooks, or other mechanical means. Fabric shall extend the full width and length of the gate.

Hinges shall be heavy pattern with large bearing surfaces and shall not twist or turn under the action of the gate. Latches shall be plunger bar type, full gate height, and arranged to engage the gate stop, except single gates less than ten feet (10') (3m) wide may be provided with a forked latch. Latches shall be arranged for padlocking with the padlock accessible from both sides of the gate. Stops shall consist of a roadway plate with anchor set in concrete arranged to engage the plunger. Keepers shall consist of mechanical devices for securing and supporting the free end of the gates when in the

full open position. Keepers shall be mounted on 1-7/8" od pipe and set in concrete foundations.

Gates shall be installed so that they cannot be removed without disassembly of the hardware.

640.04 Fence Construction

The installed fence shall conform to the alignment indicated and follow the natural grade. Unless otherwise indicated or specified, all posts shall be plumb and spaced ten feet (10') (3m) apart. Where necessary, the fence grade shall be adjusted to fit the ground contour by slipping the fence fabric links. On steep grades, the posts may be set normal to the slope, provided transition sections are constructed. Ground surface irregularities shall be graded as required to eliminate frequent changes in vertical alignment and to provide a smooth profile for the fence. Where posts are set in earth, concrete foundations twenty-four inches (24") (607mm) deep shall be provided. If bedrock is encountered, post excavation shall be continued to the twenty-four inch (24") (607mm) depth or twelve inches (12") (305mm) into the rock, whichever is less. Concrete foundations shall be circular in horizontal section, not less than twelve inches (12") (305mm) in diameter. Foundations shall be flush and horizontal with the ground surface. Concrete for foundations shall conform to section 301. Each foundation shall be cured for at least 72 hours before further work is done on the post.

Top rails and bottom tension wires shall be installed before the fabric. Top rails shall be furnished in at least eighteen-foot (18') (5.4m) lengths and shall be securely connected to gate and terminal posts. Tension wires shall be attached to each post and securely anchored at terminal and gate posts. A terminal post shall be provided at each change in slope.

Ties on the fabric will be placed one every vertical foot except on athletic fields where the ties will be placed one for every two vertical foot. Horizontal ties will be placed on the intervals recommended by the fabric manufacture.

Stretcher bars shall be provided at each gate, terminal, and pull post. Each stretcher bar shall be threaded through the fabric and anchored to the post at fifteen-inch (15") (381mm) centers by positive mechanical means.

Each gate and terminal post shall be braced by a horizontal pipe brace and an adjustable truss extending to an adjacent line post. Corner posts located where deflection angle is 10° or greater shall be braced in both directions.

The necessary clearing and grubbing shall be done to construct the fence to the required grade and alignment.

The fence shall be placed where staked by the engineer and as shown on the plans. All posts shall be plumb and firmly set.

At locations where breaks in a run of fencing are required, or at intersections with existing fences, appropriate adjustment in post spacing shall be made to conform to the requirements for the type of enclosure indicated.

When the plans require that posts, braces, or anchors be imbedded in concrete, temporary guys or braces shall be installed as required to hold the posts in proper position until the concrete has set. No materials shall be installed on posts set in concrete, or stress placed on guys and bracing until at least 72 hours after concrete placement.

Fence posts, end panels, and brace panels shall be of the materials specified on the plans. Gate tighteners for metal posts shall be constructed similar to and of the same material for those used with wooden posts.

All posts which are damaged in driving shall be removed and replaced. Wire or fencing of the size and type required shall be firmly attached to the posts and braces in the manner indicated. All wire shall be stretched taut and installed at the required elevations.

Wire or wooden fence stays of the type and size shown on the plans shall be provided where specified. No separate payment will be made for this work.

640.05 Fence Removal

- A. Contractor shall be responsible for removal of existing fence as identified on the plans. Metal line posts and fabric removed which are straight and true shall become the property of the City of Casper and delivered to the Casper Service Center, 1800 E. "K" St., Casper. All other material shall become the property of the contractor.

“LEFT BLANK ON PURPOSE”