TABLE OF CONTENTS

CHAPTER 1
GENERAL REQUIREMENTS

Page

1.00.00 AUTHORITY AND PURPOSE 1-1

1.01.00 TITLE 1-1
1.02.00 APPLICABILITY 1-1
1.03.00 AUTHORITY 1-1
1.04.00 PURPOSE 1-1
1.05.00 CITY CAPITAL IMPROVEMENT PROJECTS 1-2
1.06.00 INTERPRETATION 1-2
1.07.00 ENFORCEMENT RESPONSIBILITY 1-3
1.08.00 VIOLATIONS 1-3
1.09.00 VARIANCES 1-3
1.10.00 AMENDMENTS AND REVISIONS 1-3
1.11.00 SEVERABILITY 1-4
1.12.00 DEFINITIONS 1-4
1.13.00 ABBREVIATIONS 1-8

1.20.00 GENERAL CONDITIONS 1-10

1.21.00 RESPONSIBILITY FOR DESIGN AND CONSTRUCTION 1-10
1.22.00 PRE-CONSTRUCTION MEETINGS 1-10
1.23.00 WORK CONDITIONS 1-11
1.23.01 Emergency Work 1-11
1.23.02 Housekeeping 1-11
1.23.02 Final Clean-Up 1-11
1.24.00 CONTROL OF WORK AND MATERIALS 1-12
1.24.01 Authority of City 1-12
1.24.02 Responsibilities of the CONTRACTOR 1-12
1.24.03 Unauthorized and/or Unacceptable Work 1-13
1.24.04 Samples and Tests 1-13
1.24.05 Storage of Materials 1-14
1.24.06 Defective Materials 1-14
1.25.00 PROTECTION OF PUBLIC INTERESTS 1-14
1.25.01 Public Convenience and Safety 1-14
1.25.02 Protection of Property and Monuments 1-15
1.25.03 Installation of Survey Monuments 1-15
1.25.04 Explosives 1-16
1.25.05 Protection of Streams, Lakes, and Reservoirs 1-16
1.26.00 WORK IN PUBLIC RIGHT-OF-WAY 1-17
1.26.01 Right-of-Way Permit 1-17
1.26.02 Right-of-Way Permit Application Requirements 1-17
1.26.03 Issuance of CONTRACTOR's License Prior to Permit 1-19
1.26.04 Liability for Damage 1-19
1.26.05 Application 1-19
1.26.06 Exhibition of Permit 1-20
1.26.07 Guarantee 1-20
1.26.08 Performance 1-21
1.27.00 OTHER PERMITS 1-22

1.27.01 Land Disturbance Permit *1-22*
1.27.02 Temporary Water Service *1-22*
1.28.00 SUSPENSION OR REVOCATION OF PERMITS -- STOP WORK ORDER 1-23
1.29.00 IMPROVEMENTS AGREEMENT 1-24
1.29.01 Requirements *1-24*
1.29.02 Surety *1-24*
1.30.00 CONSTRUCTION DRAWING SUBMITTAL REQUIREMENTS 1-25
1.31.00 CONSTRUCTION MATERIAL SUBMITTAL REQUIREMENTS 1-25
1.31.01 General *1-25*
1.31.02 Submittals for Chapter 2 - Earthwork, Erosion Control and Revegetation *1-26*
1.31.03 Submittals for Chapter 3 - Water System *1-26*
1.31.04 Submittals for Chapter 4 - Sanitary Sewer System *1-26*
1.31.05 Submittals for Chapter 5 - Storm Sewer System *1-27*
1.31.06 Submittals for Chapter 6 - Roadway *1-28*
1.31.07 Submittals for Chapter 7 - Concrete *1-28*
1.31.08 Submittals for Chapter 8 - Traffic *1-29*
1.31.09 Submittals for Chapter 9 - Trenching, Backfilling and Compacting *1-29*
1.31.10 Submittals for Chapter 10 - Street Lighting *1-31*
1.31.11 Submittals for Chapter 11 - Reclaimed Water System *1-31*

CHAPTER 1
GENERAL REQUIREMENTS

1.00.00 AUTHORITY AND PURPOSE

1.01.00 TITLE

These regulations, together with all future amendments, shall be known as the CITY STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS, 2019 Edition, and may be cited as such and will be referred to herein as the STANDARDS AND SPECIFICATIONS.

1.02.00 APPLICABILITY

These STANDARDS AND SPECIFICATIONS shall apply to construction, enlargement, alteration, relocation, removal, conversion, demolition, repair, and excavation of any public improvements or private improvements of common ownership specifically regulated herein. The provision of these STANDARDS AND SPECIFICATIONS applies to CITY contracts as well as to contracts made for the development of property in the CITY. In the case of CITY capital improvement contracts, the project specifications may supersede or modify these STANDARDS AND SPECIFICATIONS. Alterations, additions or repairs to existing improvements shall comply with all requirements of these STANDARDS AND SPECIFICATIONS unless specifically exempted, in writing, by the CITY ENGINEER. The CITY ENGINEER retains the right to require additional information, criteria, or requirements as conditions may warrant.

1.03.00 AUTHORITY

These STANDARDS AND SPECIFICATIONS have been enacted pursuant to Section 11-6-5 of the CITY CODE and Title 31 of Article 16 of the Colorado Revised Statutes and shall have the same force and effect as all other ordinances of the CITY.

Wherever the words “as directed”, “as required”, “as permitted”, or words of like meaning are used, it shall be understood that the direction, requirements, or permission of the CITY ENGINEER is intended. Similarly, the words “approved”, “acceptable”, “satisfactory” shall refer to approval by the CITY ENGINEER.

1.04.00 PURPOSE

The purpose of these STANDARDS AND SPECIFICATIONS is to provide minimum standards to safeguard life, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use, location, and maintenance of all public improvements and private improvements of common ownership including, but not limited to, sanitary sewer systems, water supply systems, storm drainage systems, streets, street lights, traffic control devices, trails, open space, parking lots, and appurtenances thereto.

The purpose of these STANDARDS AND SPECIFICATIONS is also to ensure that the CITY receives public facilities which are constructed with the care and materials such that the facility meets or exceeds the normal service life and quality requirements for similar installations and to insure that when said facilities are transferred to the CITY's ownership that they will be free from all defects and in suitable working order to provide the service capabilities anticipated with such a facility in a sustainable manner.

1.05.00 CITY CAPITAL IMPROVEMENT PROJECTS

It is recognized that the minimum requirements contained in these STANDARDS AND SPECIFICATIONS are not necessarily sufficient for plans, specifications, and contract administration purposes for CITY administered capital improvement projects. Accordingly, the CITY ENGINEER is authorized to develop and/or approve such additional requirements and procedures necessary for bidding, awarding, and administering for such projects, provided said additional requirements and procedures are substantially consistent with these STANDARDS AND SPECIFICATIONS and applicable provisions of other CITY ordinances and resolutions.

1.06.00 INTERPRETATION

In the interpretation of the provisions of these STANDARDS AND SPECIFICATIONS the following shall govern:

(A) In its interpretation, the provisions of these STANDARDS AND SPECIFICATIONS shall be regarded as the minimum requirements for the protection of the public health, safety, comfort, convenience, prosperity, and welfare of the residents of the CITY.

(B) Whenever a provision of these STANDARDS AND SPECIFICATIONS or any provision in any law, ordinance, resolution, rule or regulation of any kind, contain any restrictions covering any of the same subject matter, whichever standards are more stringent shall govern.

(C) These STANDARDS AND SPECIFICATIONS shall not abrogate or annul any permits or approved drainage reports and construction plans issued or any easement or covenant granted before the effective date of these STANDARDS AND SPECIFICATIONS. However, if the review and approval of construction plans, specifications, and associated engineering reports by the CITY ENGINEER has occurred more than twelve (12) months prior to execution of the IMPROVEMENTS AGREEMENT/or commencement of construction activities, or if significant change has occurred in specifications or requirements, the CITY ENGINEER shall have the right to require another review process for the plans, specifications, and reports to insure compliance with these STANDARDS AND SPECIFICATIONS.

(D) In case of a discrepancy in a requirement among different documents, the order of precedence is as follows:

(1) Project special provisions

(2) Construction drawings and details

(3) These STANDARDS AND SPECIFICATIONS

(4) Standard drawings

1.07.00 ENFORCEMENT RESPONSIBILITY

It shall be the duty of the CITY ENGINEER to enforce the provisions of these STANDARDS AND SPECIFICATIONS.

1.08.00 VIOLATIONS

No person, firm, or corporation shall construct, enlarge, alter, repair, relocate, improve, remove, excavate, convert, or demolish any PUBLIC IMPROVEMENTS or private improvements in common ownership or permit the same to be done in violation of these STANDARDS AND SPECIFICATIONS. Whenever any work is being done contrary to the provisions of these STANDARDS AND SPECIFICATIONS, the CITY ENGINEER or their designee may order the work stopped by a written notice in accordance with Section 1.28.00 of these STANDARDS AND SPECIFICATIONS.

1.09.00 VARIANCES

The provisions of these STANDARDS AND SPECIFICATIONS are not intended to prevent the use of any material or method of construction not specifically prescribed by these standards, provided any alternate has been approved and its use authorized in writing by the CITY ENGINEER.

Whenever there are practical difficulties involved in carrying out the provisions of these procedures, the CITY ENGINEER may grant a variance for individual cases, provided that the CONTRACTOR or DEVELOPER provide evidence that a unique reason makes these standards impractical and that the modification is in conformity with the intent and purpose of these standards, and providing that such variance does not lessen any design requirements or any degree of structural or operational integrity, and results in a level of safety, service, and quality equal to or greater than that intended by the application of the minimum requirements. The CITY ENGINEER shall require that sufficient specifications, evidence, justification, and/or proof be submitted to substantiate any claims that may be made regarding the alternate material, detail, or technique. The CITY ENGINEER, in their sole discretion, will decide upon the acceptability of any proposed variance.

1.10.00 AMENDMENTS AND REVISIONS

These STANDARDS AND SPECIFICATIONS may be amended as new technology is developed and/or if experience gained in the use of these STANDARDS AND SPECIFICATIONS indicate a need for revision. The CITY shall have full power and authority to promulgate rules, regulations, or new standards of a technical nature,

which rules, regulations, or standards shall be effective immediately upon their approval and certification by the CITY ENGINEER. It is the responsibility of the Consultant/CONTRACTOR/DEVELOPER to obtain all revisions to these STANDARDS AND SPECIFICATIONS. The most recent version of these can be found at: https://www.cityofwestminster.us/standardsandspecifications

1.11.00 SEVERABILITY

If any section or article of these STANDARDS AND SPECIFICATIONS is found to be unconstitutional or illegal by any court, the said section or article shall have no bearing on the effectiveness of the rest of these STANDARDS AND SPECIFICATIONS.

1.12.00 DEFINITIONS

ACCEPTANCE shall mean the formal approval of a work element by the CITY ENGINEER or CITY INSPECTOR that the work element has fulfilled contract or PUBLIC IMPROVEMENT AGREEMENT requirements. Acceptance may mean "into warranty" or "out of warranty" depending on the IMPROVEMENTS AGREEMENT and WORK.

ALLEY shall mean a narrow passageway, generally one lane, behind or between buildings for garage and service access.

BEST MANAGEMENT PRACTICE shall mean a technique, process, activity, or structure used to reduce pollutant discharges in stormwater. BMPs include source control practices (non-structural BMPs) and engineered structures designed to treat runoff.

BRIDGE shall mean a structure, including supports, erected over a depression or an obstruction, such as water, highway or railroad, and having a track or passageway for carrying traffic or other moving loads.

CITY shall mean the City of Westminster, in the State of Colorado, acting by and through the CITY MANAGER, Mayor, and CITY Council.

CITY CODE shall mean the current adopted Westminster Municipal Code.

CITY ENGINEER shall mean the CITY ENGINEER or authorized representative for the CITY.

CITY INSPECTOR shall mean the CITY ENGINEER's authorized representative assigned to make detailed inspections of the WORK.

CITY MANAGER shall mean the CITY Manager or authorized representative for the CITY.

CLASS D PUBLIC WAY CONTRACTOR shall mean a CONTRACTOR holding a valid CITY Class D business license, pursuant to Section 5-5 of the CITY CODE, authorizing

the CONTRACTOR to perform work affecting public property or grounds, utility systems (either CITY-owned or contracting with the CITY for service of any type) or work within any street right-of-way, utility easement, or other public property.

COMMUNITY DEVELOPMENT DIRECTOR shall mean the Director of the Community Development Department or authorized representative for the CITY.

CONSTRUCTION DRAWINGS shall mean approved final documents depicting the extents and type of work to be completed.

CONTRACTOR shall mean a person, company, firm, or corporation licensed and bonded in the CITY in accordance with the CITY CODE.

CULVERT shall mean a drainage structure that may or may not directly support traffic and that extends across and beneath a highway, street, driveway, alley, arterial, path or other public way.

DATE OF COMPLETION shall mean the date the work is required to be accepted into warranty.

DEVELOPER shall mean a person, company, firm, private utility company, or corporation that is developing or seeking to develop a property, including, but not limited to, the design engineer, within the CITY. For a private utility company, this includes performing system improvements or substantial maintenance within RIGHT-OF-WAY.

DRAINAGE CRITERIA MANUAL shall mean the CITY Storm Drainage Design and Technical Criteria Manual, latest version.

EMERGENCY WORK shall mean work deemed necessary by the CITY for the safety of the public or the protection of the work to be constructed, or if adjacent structures or property which may be damaged by processes of construction on account of neglect, and an emergency arises and immediate action is considered necessary in order to protect private or public interests.

IMPROVEMENTS AGREEMENT shall mean the PUBLIC IMPROVEMENTS AGREEMENT and/or the LANDSCAPE AND PRIVATE IMPROVEMENTS AGREEMENT.

LAND DISTURBANCE AGREEMENT shall mean an agreement between the OWNER and the CITY that is required according to Section 8-11-5 of CITY CODE when land disturbance requires a Land Disturbance Permit and an IMPROVEMENTS AGREEMENT is not in place.

LANDSCAPE AND PRIVATE IMPROVEMENTS AGREEMENT shall mean the approved written contract between the OWNER and the CITY for construction of private improvements including all on-site and off-site landscaping required to be installed pursuant to the official development plan for the project, whether on private or public property, as well as all on-site amenities to be privately owned and maintained in areas of private or common ownership, including, but not limited to,

sewer systems, water and sewer service lines to buildings, grading, drainage structures, retaining walls, parking lots, private streets and walks, fire lanes, driveways, fencing, screening, trash enclosures, trails, swimming pools, tennis courts, and community recreation facilities.

METHOD OF HANDLING TRAFFIC shall mean a plan submitted which shows the CONTRACTOR's proposed construction phasing and proposed traffic control devices. An MHT shall be submitted for each different phase of construction. Individual MHTs shall make up part of a project's TRAFFIC CONTROL PLAN. An MHT shall include as a minimum the following:

- A detailed diagram of all traffic control devices, including signs and flaggers.
- Length and time duration of all lane closures.
- An access maintenance plan for all properties requiring access during construction.
- Staging and storage areas.
- A plan for maintaining and controlling pedestrian, bicycle and other non-vehicular traffic.
- A plan for emergency vehicle access.

MS4 shall mean Municipal Separate Storm Sewer System, which is a publicly owned conveyance or system of conveyances that discharges to waters of the U.S. and is designed or used for collecting or conveying stormwater, is not a combined sewer, and is not part of a publicly owned treatment works (POTW). An MS4 may be subject to an MS4 Permit, a state or federal stormwater discharge permit to regulate discharges from MS4s for compliance with Clean Water Act regulations.

NOTICE TO PROCEED shall mean formal notice given by the CITY to a DEVELOPER, OWNER or CONTRACTOR that the work may proceed according to the contract or IMPROVEMENTS AGREEMENT.

OWNER shall mean a person, company, firm, or corporation holding title to land that is being developed or modified within the CITY.

PERMIT shall mean any applicable permits required to complete the WORK, including:

- Land Disturbance Permit: As defined and required in Section 8-11-5 of CITY CODE.
- Floodplain Development Permit: As defined and required in Section 11-8-13(I) of CITY CODE.
- Right-of-Way Permit: As defined and required in Section 9-2-1 of CITY CODE.
- Online Permit System: The electronic online system (ETRAKIT or successor) available on the CITY's public website which provides for the electronic application, viewing and tracking of permits and development proposals.

PLANS shall mean civil construction drawings, a development plan, capital improvement plan, or other final documents approved by the CITY ENGINEER, depicting the construction WORK to occur.

PRIVATE IMPROVEMENTS includes: private sewer systems, water and sewer service lines to buildings, grading, drainage structures, retaining walls, parking lots, private streets and walks, fire lanes, driveways, and associated construction.

PUBLIC IMPROVEMENTS include: all work in the public right-of-way, easements dedicated to the CITY, and projects or utilities that will become the CITY's responsibility to maintain.

PUBLIC IMPROVEMENTS AGREEMENT shall mean the approved written contract between the OWNER and the CITY for construction of public improvements including streets, curbs, gutters, culverts, drainage channels, utilities, traffic control devices, park facilities, and other features that will be owned and/or maintained by the CITY.

RELEASE FOR SERVICE shall mean the water and/or sanitary sewer utility has been installed, tested, and inspected by the CITY and is able to serve its intended users according to the PLANS. Release for Service does not mean the WORK has been accepted by the CITY, and is subject to inspection and the requirements of the IMPROVEMENTS AGREEMENT.

RIGHT-OF-WAY shall mean any street, alley, sidewalk, path, tree lawn or utility corridor in the CITY that is publically owned and/or is responsible for maintaining.

SHOP DRAWING shall mean drawings, diagrams, illustrations, samples, schedules, calculations, and other data which provide details of the construction of the work and details to be used by the CITY ENGINEER or Designee for inspection. Shop Drawings shall be prepared by the CONTRACTOR, SUBCONTRACTORs, manufacturers, suppliers, or distributors. Shop drawings are submitted to the CITY ENGINEER for formal review and returned to the CONTRACTOR. Shop drawings include data which illustrates material, equipment, and items which are incorporated in and become part of the permanent work.

STANDARDS AND SPECIFICATIONS shall be understood that reference is made to the CITY STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS, latest version.

STORMWATER MANAGEMENT PLAN shall mean a written plan identifying measures that will be implemented to minimize the discharge of pollutants in stormwater. Requirements for SWMPs are legally specified in CITY, state and federal discharge permits. Requirements vary depending on whether the discharge permit is associated with municipal, industrial, or construction activities.

SUBCONTRACTOR shall mean any person, company, firm, or corporation licensed and bonded in the CITY in accordance with the CITY CODE which has a direct or indirect contract with the CONTRACTOR or other contractor and furnishes and/or performs on-site labor, and/or furnishes materials in connection with the performance of the WORK.

SUBMITTAL shall mean a sample and/or data provided to the CITY INSPECTOR for approval of a material or product the CONTRACTOR intends to use in construction.

SURETY shall mean the entity which is bound with and for the OWNER for the performance of the WORK as described in these STANDARDS AND SPECIFICATIONS.

TESTING AGENCY shall mean any individual, partnership, or corporation which is qualified and licensed to perform the required sampling, analysis, testing, and professional recommendation service.

TRAFFIC CONTROL PLAN shall mean the parts of the contract, IMPROVEMENTS AGREEMENTS or PERMIT that contain the requirements for the maintenance of traffic during construction.

TRAFFIC ENGINEER shall mean the Traffic Engineer or authorized representative of the CITY.

UNDERDRAIN shall mean a subsurface pipe, which may be perforated, intended to collect groundwater and convey it to a designated outlet.

WARRANTY shall mean the period following completion of the work that the OWNER or DEVELOPER is responsible for necessary repairs pursuant to Section 1.26.06 of these STANDARDS AND SPECIFICATIONS.

WATERS OF THE US shall mean all waters in which the U.S. Army Corps of Engineers have jurisdiction, are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters subject to the ebb and flow of the tide. Section 404 permit requirements apply.

WORK shall mean the furnishing of all labor, materials, equipment, and incidentals necessary to successfully complete the project according to all duties and obligations imposed by the contract, PERMIT or IMPROVEMENTS AGREEMENT.

WORKING DAYS shall be based on Westminster City Hall normal business hours.

1.13.00 ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AISC	American Institute of Steel Construction
APM	Asphalt Paving Mixture
ANSI	American National Standards Institute
APWA	American Public Works Association
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AWWA	American Water Works Association

AWG	American Wire Gauge, as defined in ASTM B 258
BMP	Best Management Practice
CBC	Concrete Box Culvert
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CIP	Capital Improvement Project
CLOMR	Conditional Letter of Map Revision, for FEMA regulated floodplains
CMP	Corrugated Metal Pipe
CMPA	Corrugated Metal Pipe Arch
CRS	Colorado Revised Statutes
CRSI	Concrete Reinforcing Steel Institute
CUHP	Colorado Urban Hydrograph Procedure
CWCB	Colorado Water Conservation Board
DIP	Ductile Iron Pipe
DRCOG	Denver Regional Council of Governments
FDIC	Federal Deposit Insurance Corporation
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
HBP/HMA	Hot Bituminous Pavement / Hot Mix Asphalt
HDPE	High Density Polyethylene
HERCP	Horizontal Elliptical Reinforced Concrete Pipe
IMSA	International Municipal Signal Association
ITE	Institute of Transportation Engineers
LDA	Land Disturbance Agreement
LDP	Land Disturbance Permit
LED	Light Emitting Diode
LOMR	Letter of Map Revision, for FEMA regulated floodplains
LPIA	Landscaping and Private Improvements Agreement
MGPEC	Metropolitan Government Pavement Engineers Council
MHT	Method of Handling Traffic
MS4	Municipal Separate Storm Sewer System
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electric Code
NEMA	National Electric Manufacturers Association
NFIP	National Flood Insurance Program
NPDES	National Pollution Discharge Elimination System
NTP	Notice to Proceed
ODP	Official Development Plan
OSHA	Occupational Safety and Health Association
PACP	Pipeline Assessment Certification Program
PDP	Preliminary Development Plan
PIA	Public Improvements Agreement
POTW	Public Owned Treatment Works
PUD	Planned Unit Development
PVC	Polyvinyl Chloride
PWU	Public Works & Utilities
RAP	Reclaimed Asphalt Pavement
RCBC	Reinforced Concrete Box Culvert

RCP	Reinforced Concrete Pipe
ROW	Right-of-Way
SCS	Soil Conservation Service
SDDTCM	Storm Drainage Design and Technical Criteria Manual
SMA	Stone Matrix Asphalt
SPP	Structural Plate Pipe
SPPA	Structural Plate Pipe Arch
SWMP	Stormwater Management Plan
TCP	Traffic Control Plan
TMUND	Traditional Mixed Use Neighborhood Development
UDFCD	Urban Drainage and Flood Control District
UNCC	Utility Notification Center of Colorado
USACOE	United States Army Corps of Engineers
USDCM	Urban Storm Drainage Criteria Manual (MANUAL)
USGS	United States Geological Survey

1.20.00 GENERAL CONDITIONS

1.21.00 RESPONSIBILITY FOR DESIGN AND CONSTRUCTION

The CITY of Westminster shall have full authority to review and approve all submittals and construction for compliance with these STANDARDS AND SPECIFICATIONS. An approval or acceptance by the CITY does not relieve the OWNER, engineer, designer, or CONTRACTOR from responsibility for ensuring that the calculations, plans, specifications, construction, and record drawings are in compliance with these STANDARDS AND SPECIFICATIONS and applicable laws and regulations, including the Americans with Disabilities Act.

The DEVELOPER shall provide a Subsurface Utility Engineering (SUE) Plan at the time of Civil CD submittal locating the City-owned utility conflicts. For all Proposed/Existing utility crossing Quality Level A is required and for all other utilities, Quality Level B or better. Quality Levels shall be in accordance with ASCE 38. When proposed public utilities crosses existing gravity sewer, written approval from the CITY ENGINEER may permit a non-invasive alternative Modified Quality Level A.
Any approval or acceptance by the CITY shall not result in any liability to the CITY or its employees for any claim, suit, loss, damage, or injury resulting from the use or implementation of the approved documents. Nothing in these STANDARDS AND SPECIFICATIONS shall be construed to circumvent Section 11-6-5(B)3 of the CITY CODE pertaining to responsibility for reports, studies, designs, and construction.

1.22.00 PRE-CONSTRUCTION MEETINGS

In conjunction with the NTP for a development, the CITY INSPECTOR shall arrange a "pre-construction meeting" which shall be attended by the OWNER/DEVELOPER, all of the OWNER/DEVELOPER's CONTRACTORs, affected utility companies and the appropriate CITY ENGINEERs. This meeting shall be held before any construction-related activities can commence on said development, and its purpose is to introduce all of the "parties" involved in the development as well as establish guidelines that the CITY feels are appropriate for the development.

Prior to construction, the CONTRACTOR shall document existing public improvements adjacent to the work, including, but not limited to, sidewalks, driveways, utility appurtenances, drainage structures, traffic control devices and survey monuments. The CONTRACTOR shall provide videos or digital photographs of the existing public improvements prior to or at the pre-construction meeting. The CITY ENGINEER may also require post-construction documentation of the existing PUBLIC IMPROVEMENTS.

1.23.00 WORK CONDITIONS

1.23.01 Emergency Work

When, in the opinion of the CITY, the CONTRACTOR has not taken sufficient precautions for the safety of the public or the protection of the work to be constructed, or if adjacent structures or property which may be damaged by processes of construction on account of such neglect, and an emergency arises and immediate action is considered necessary in order to protect private or public interests, the CITY, with or without notice to the CONTRACTOR or the DEVELOPER, may provide suitable protection by causing work to be done and material to be furnished and placed as the CITY may consider necessary and adequate. The cost and expense of such work and material so furnished will be borne by the CONTRACTOR or DEVELOPER and will be paid within 30 days of presentation of the bills. The CITY may also draw from the DEVELOPER's surety to cover any non-payment, including accrued interest and reasonable overhead costs. The performance or non-performance of such emergency work under the direction of the CITY will in no way relieve the CONTRACTOR of responsibility for damages which may occur during or after such precaution has been taken.

1.23.02 Housekeeping

The CONTRACTOR shall keep the work site in an orderly condition. Accumulation of trash, debris, etc. is not allowed. The CONTRACTOR shall clean the site as required by applicable provisions, including conditions in any IMPROVEMENTS AGREEMENTS or PERMIT.

1.23.02 Final Clean-Up

Upon completion of the work and prior to any inspection by the CITY INSPECTOR, the CONTRACTOR shall remove from the project area all surplus and discarded material, rubbish, and temporary structures and leave the project area in a neat and presentable condition. The CONTRACTOR shall restore all work which has been damaged by their operations to general conformity with the specifications for the item(s) involved. The CONTRACTOR shall inspect the interior of all manholes and catch basins within the construction limits for construction materials, dirt, stones, or other debris and remove same prior to any inspection by the CITY INSPECTOR.

1.24.00 CONTROL OF WORK AND MATERIALS

1.24.01 Authority of City

The CITY ENGINEER will have the authority to stop work whenever such stoppage may be deemed necessary. The CITY ENGINEER will resolve all questions which arise as to the quality and acceptability of materials furnished, work performed, interpretation of the plans and specifications, and acceptable fulfillment of the requirements of these STANDARDS AND SPECIFICATIONS.

CITY INSPECTORS are authorized to inspect all work and all material furnished at any time. Inspections may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The inspector is not authorized to revoke, alter, or waive any requirements of these STANDARDS AND SPECIFICATIONS. They are authorized to call the attention of the CONTRACTOR to any failure of the work or materials to conform to these STANDARDS AND SPECIFICATIONS. The CITY INSPECTOR will have the authority to reject materials until any questions at issue can be resolved by the CITY.

The CITY INSPECTOR will, in no case, act as foreman or perform other duties for the CONTRACTOR nor interfere with the management of the work done by the CONTRACTOR. Any "advice" or "opinion" which the inspector may give the CONTRACTOR will not be construed as binding upon the CITY ENGINEER or the CITY of Westminster in any way or release the CONTRACTOR from fulfilling all of the terms of these STANDARDS AND SPECIFICATIONS. The presence or absence of the inspector will not relieve, in any degree, the responsibility or the obligation of the CONTRACTOR, OWNER or DEVELOPER.

The CITY INSPECTOR will, at all times, have reasonable and safe access to the work as it progresses and the CONTRACTOR will provide proper facilities for such access and inspection. If the CITY INSPECTOR deems the site conditions unsafe to access, the CITY INSPECTOR has the right to refuse inspection until proper access is provided.

1.24.02 Responsibilities of the CONTRACTOR

In case of suspension of work for any cause, the CONTRACTOR, before leaving the job site, will take such precautions as may be necessary to prevent damage to the project, provide for public safety, protect utilities, allow normal drainage, and erect any necessary barricades, signs, or other facilities at their expense as directed by the CITY ENGINEER and/or CITY INSPECTOR and required by these STANDARDS AND SPECIFICATIONS. The CONTRACTOR is responsible for ensuring that all construction and construction activities and materials are in compliance with these STANDARDS AND SPECIFICATIONS. The CONTRACTOR shall be solely responsible for all construction means, methods, techniques, sequences, and procedures. The CONTRACTOR shall be responsible for the acts and omissions of their employees, subcontractors, and

their agents and employees. The CONTRACTOR shall notify Colorado 811 and be solely responsible for locating all existing underground installations, including service connections, in advance of excavating. CITY utility maps are intended to be used for general information only, and the location of any utilities or property lines as shown on the utility maps are not necessarily accurate.

1.24.03 Unauthorized and/or Unacceptable Work

Work which does not conform to the approved construction PLANS and these STANDARDS AND SPECIFICATIONS and results in an inferior or unsatisfactory product will be considered unacceptable work. Unacceptable work, whether the result of poor workmanship, poor design, use of defective materials, damage through carelessness, or any other cause which is found to exist prior to the final acceptance of the work will be immediately removed and replaced or otherwise satisfactorily corrected by and at the expense of the DEVELOPER or CONTRACTOR. This expense includes total and complete restoration of any disturbed land or surface to original or better condition that existed before the repairs or replacement.

1.24.04 Samples and Tests

To ascertain that materials and procedures comply with contract requirements, testing will be taken at the source or at the job destination at the discretion of the CITY ENGINEER and as often as the CITY ENGINEER deems it advisable or necessary. Taking of samples will be in accordance with standard practices except where methods and procedures for sampling materials are otherwise set forth in these STANDARDS AND SPECIFICATIONS.

The CONTRACTOR will furnish, without charge, all samples and test results required by the CITY ENGINEER and will afford such facilities as may be necessary for collecting and forwarding them. The CONTRACTOR may be required to furnish, when requested by the CITY ENGINEER, a written statement giving the origin, composition, and process of manufacture of a material.

Whenever any of the provisions of these STANDARDS AND SPECIFICATIONS or evidence that any material or construction does not conform to the requirements herein, the CITY ENGINEER may require that the CONTRACTOR have tests performed, at their expense, which will be used as proof of compliance. Test methods will be as referenced by these STANDARDS AND SPECIFICATIONS. If there are no recognized and accepted test methods for the proposed alternate, the CITY ENGINEER will determine the test procedures. All tests will be made by a testing agency approved by the CITY ENGINEER. Reports and results of such tests will be retained by the CITY ENGINEER.

1.24.05 Storage of Materials

Materials will be stored so as to ensure the preservation of their quality and suitability for the work. Stored materials, even though approved prior to storage, will be subject to inspection prior to their use in the work and will meet all requirements of these STANDARDS AND SPECIFICATIONS at the time they are used. Stored materials will be located so as to facilitate inspection. With the prior written approval of the CITY ENGINEER, portions of the right-of-way not required for public travel may be used for storage purposes and for the placing of the CONTRACTOR's plants and equipment, but any additional space required will be provided by the CONTRACTOR at their expense.

1.24.06 Defective Materials

Materials not in conformance with requirements of these STANDARDS AND SPECIFICATIONS will be considered defective and will be rejected. Rejected materials will be removed from the work site at the CONTRACTOR's expense, unless otherwise permitted by the CITY ENGINEER.

1.25.00 PROTECTION OF PUBLIC INTERESTS

1.25.01 Public Convenience and Safety

Unless otherwise specified, the CONTRACTOR will give written notice, to the proper authorities in charge of streets; gas and water pipes; electric service, cable television, and other conduits; railroads; poles; manholes; catch basins; and all other property that may be affected by the CONTRACTOR's operations at least three (3) working days or based on authority's requirements prior to any construction. The CONTRACTOR will not hinder or interfere with any person in the protection of such property or with the operation of utilities at any time. The CONTRACTOR must obtain all necessary information in regard to existing utilities, protect such utilities from injury, and avoid unnecessary exposure so that they will not cause injury to the public.

The CONTRACTOR will obtain all necessary information concerning the planned installation of new utilities and cables, conduits and transformers, make proper provision and give proper notification so that new utilities and appurtenances can be installed at the proper time and location to avoid unnecessary inconvenience to the OWNER or the public. New underground utilities and appurtenances will not be covered with pavement prior to the City's inspection of such facilities. When the work involves excavation adjacent to any building or wall along the work, the CONTRACTOR will give property owners due and sufficient written notice thereof, with a copy to the CITY ENGINEER.

1.25.02 Protection of Property and Monuments

The DEVELOPER and CONTRACTOR will use every reasonable precaution to prevent the damage or destruction of public or private property such as, but not limited to, poles, trees, shrubbery, crops, fences, monuments and all overhead structures such as, but not limited to, wires or cables which are either within or outside of the right-of-way. The CONTRACTOR will protect and support all water, gas, sanitary sewer, storm sewer, electrical pipes, conduits, and all railway tracks, buildings, walls, fences, or other properties which are liable to be damaged during the execution of their work. The CONTRACTOR will take all reasonable and proper precautions to protect persons, animals and vehicles from injury or damage and, as necessary or as directed by the CITY ENGINEER and/or CITY INSPECTOR will erect and maintain fencing, traffic control devices or other protective measures. The CONTRACTOR will employ one or more watchmen as additional security whenever they are needed or required by the CITY ENGINEER. The CONTRACTOR will not prevent the flow of water in the gutters of the street and will use proper means to permit the flow of surface water along the gutters while the work is in progress.

The CONTRACTOR will protect and carefully preserve all land boundary and CITY survey control monuments until the OWNER's authorized registered land surveyor has referenced their location for replacement. All monuments disturbed or removed by the CONTRACTOR through negligence or carelessness on their part or on the part of their employees or subcontractors will be replaced by a land surveyor registered in the State of Colorado, at the CONTRACTOR's expense. The DEVELOPER and CONTRACTOR will be responsible for the repair of any damage or destruction of property resulting from neglect, misconduct, or omission in their manner or method of execution or non-execution of the work, defective work or the use of unsatisfactory materials. The CONTRACTOR will restore such property to a condition equal to or better than that existing before such damage or injury was done by repairing, rebuilding, or replacing it as may be directed by the CITY ENGINEER, or they will otherwise make amends for damage or destruction in a manner acceptable to the CITY ENGINEER. The DEVELOPER and CONTRACTOR will be responsible for the repair of underground pipes, wires, or conduits damaged by them or their SUBCONTRACTORs.

The OWNER and CONTRACTOR will be liable for all damage caused by storms and fire for the duration of the warranty period until the WORK is accepted.

1.25.03 Installation of Survey Monuments

Permanent survey monuments, and lot pins shall be set at locations approved by the CITY ENGINEER; at all angle points; and at the beginning, end, and points of change of direction or change of radius of any curved boundary. In addition, 5/8-inch steel pins, or larger, shall be set at all lot corners. Affixed securely to the top of each monument shall be an aluminum cap marked

with the Colorado registration number of the land surveyor responsible for the establishment of the monument.

The Professional Land Surveyor will assure that the monuments he establishes or re-establishes conform both in location and physical character with the specifications called for in Section 38-51-104, CRS. Each found monument verified in location shall be restored or rehabilitated as necessary so as to have it readily identifiable and reasonably durable.

1.25.04 Explosives

When blasting is permitted and approved in writing by the CITY ENGINEER, the DEVELOPER and CONTRACTOR will use the utmost care to protect life and property. Signals warning persons of danger will be given before any blast. Excessive blasting or overshooting will not be permitted. The CITY ENGINEER will have authority to order any method of blasting discontinued which leads to overshooting, is dangerous to the public, or destructive to property, environment or natural features.

Before any blasting will be done by the CONTRACTOR, a certificate of insurance indicating special blasting coverage in the following minimum amounts will be filed with the CITY ENGINEER:

Property Damage, each accident	$1,000,000
Public Liability, bodily Injury	$1,000,000
single limit or equivalent, each accident	

The CITY ENGINEER reserves the right to require additional insurance coverage if the circumstances warrant.

The CITY ENGINEER has the right to require detailed inspections by an independent consultant or by CITY INSPECTORS on any structures or properties located in the vicinity of the blasting, both before and after the blasting activity. The cost for such inspections shall be the responsibility of the DEVELOPER and CONTRACTOR.

1.25.05 Protection of Streams, Lakes, and Reservoirs

The DEVELOPER and CONTRACTOR will take all necessary precautions to prevent pollution of streams, lakes, and reservoirs by sediment, fuels, oils, bitumens, calcium chloride, fertilizers, insecticides, or other harmful materials. They will conduct and schedule their operations to avoid or minimize siltation of streams, lakes, and reservoirs. A stormwater management plan for erosion protection shall be submitted and approved by the CITY ENGINEER. All required erosion control measures shall be in place before starting work. All work must conform to all applicable local, state, and federal regulations including, but not limited to, MS4.

1.26.00 WORK IN PUBLIC RIGHT-OF-WAY

1.26.01 Right-of-Way Permit

It shall be unlawful for any person to perform work within CITY RIGHT-OF-WAY without first obtaining permission from the CITY. If the work to be performed involves a CITY utility in CDOT right-of-way, both a Right-of-Way Permit from the CITY and the appropriate permit from CDOT shall be required. An application for work done under a Right-of-Way Permit shall be submitted for each job to the CITY utilizing the Online Permit System provided by the CITY. The application shall be submitted a minimum of three (3) working days prior to the planned start of work to allow for review and approval by the CITY ENGINEER and meet the minimum notification requirements contained within Section 1.25.01. Permittees may be required to increase this time up to ten (10) working days. An application form (when approved) shall constitute a valid PERMIT. Incomplete permit applications will not be reviewed or processed by the CITY. The CONTRACTOR shall provide notice to the CITY forty-eight (48) hours prior to the commencement of the WORK.

The CITY ENGINEER may require submittal of PLANS and specifications. No work shall commence until the CITY ENGINEER has approved the PLANS and specifications and/or permit application, except in emergency conditions. A permit application shall be required for emergency conditions within seventy-two (72) hours after the performance of the work and all conditions of a Right-of-Way Permit shall apply.

1.26.02 Right-of-Way Permit Application Requirements

The CITY ENGINEER authorizes and issues permits for the installation and maintenance of utilities within the ROW. It is deemed necessary to require construction quality drawings for new utility installations in ROW because of the continued demand for additional utility use within the ROW, and to ensure the most efficient use of the ROW. The following are drawing submittal requirements:

(A) General

1. Numerical and bar scale (Scale not to exceed 1:40)
2. North arrow
3. Legend
4. Vicinity map, as necessary
5. Plan set date and revision number (if applicable)
6. Pothole Right-of-Way permit #
7. Signature and seal of the Professional Engineer registered in the State of Colorado and in responsible charge for preparing the plans. Plan

View (Aerial imagery is allowed, however, does not replace requirement for accurately scaled engineering drawings)

(B) Show, label and dimension existing:

1. Right-of-way width
2. Edge of Pavement and/or curb and gutter
3. Sidewalks
4. Street lights
5. Pedestrian lights
6. Signal Poles
7. Surface utility features such as power poles, electric cabinets, hand-hole boxes, manhole lids, storm drainage inlets, traffic control boxes, fire hydrants and manhole covers
8. Underground utilities (water, storm sewer, sanitary sewer, gas, electric, etc.), located in accordance with *ASCE Standard 38, latest version, Quality Level B or Quality Level A where crossing any City facilities and private service laterals to said City facilities
9. Pothole information, including northing and easting, top of utility elevation, utility diameter and utility material
10. Nearby driveways and alleys
11. Street names
12. Regional Transportation District (RTD) bus stop, with any amenities including bench/shelter, signage, bus pad and bench pad

(C) Show, label and dimension proposed:

1. Underground utilities (bore line, trenching, conduit, fiber, pipes, lines, etc.) with appropriate detail shown with leader call-out
2. Surface utilities (cabinets, hand holes, poles, foundations, etc.) with appropriate detail shown with leader call-out
3. Dimensions necessary to accurately locate proposed utility (e.g. distance from back of curb, distance from existing cabinet, distance from alley or intersection
4. If areas have been disturbed and if applicable for your project, details for rehab/replacement shall be shown on plans.

(D) Elevation information at location of all potholes or Cross Section Views (If necessary or requested to show vertical clearance from other underground utilities)

1. Existing grade
2. Existing utilities located in accordance with *ASCE Standard 38, latest version, Quality Level B for all non-City owned facilities and Quality Level A where crossing any City facilities and private service laterals to said City facilities

3. Proposed utility
4. Station (STA) location
5. Scale
6. Street Name
7. ROW

*American Society of Civil Engineers

Once a complete application is received the "Review Process" will take a minimum of two
CITY working days not counting the day of submittal. Additional review time may be required based on the size of the project or if additional information is required. If additional information is required for an application, it will need to be submitted in the same manner as the original, simply change the date.

For some utility installations construction quality drawings may not be necessary. To apply for a waiver of this requirement: simply include a letter stating the reasons why along with a sketch of the work area with the ROW Permit Application. The CITY ENGINEER will contact you regarding the approval or disapproval of this request. Design and construction drawing revisions may be required when field conditions warrant, as directed by the CITY ENGINEER.

1.26.03 Issuance of CONTRACTOR's License Prior to Permit

The CITY ENGINEER may grant permits to work in, construct, or excavate within the public right-of-way or to close traffic lanes or work in connection with a CITY utility system to any CLASS D PUBLIC WAY CONTRACTOR filing an application as herein provided, which application shall pertain to work which shall comply with the requirements of this chapter. All permits shall be issued according to the provisions of Section 9-2-1 of the CITY CODE for CLASS D PUBLIC WAY CONTRACTORS.

1.26.04 Liability for Damage

Any person who shall undertake work pursuant to a permit issued under the provisions of this chapter, shall be answerable for any damage or injury to persons, animals, or public or private property as a result of any circumstances of such work. Prior to any excavation within the RIGHT-OF-WAY, the CONTRACTOR shall contact Colorado 811 and comply with their regulations as required by Senate Bill 18-167, and any other affected utilities within the vicinity of the WORK.

1.26.05 Application

Application for a permit to work in the public right-of-way shall be made utilizing the Online Permit System for the CITY.

Applicants shall pay a fee to the CITY before issuance of such permit. The amount of that fee shall be established by the CITY.

1.26.06 Exhibition of Permit

All required permits shall be kept at the site of the excavation while the work is in progress and shall be exhibited upon request to the CITY INSPECTOR. Failure to comply with this provision shall be grounds for a revocation of the permit and the issuance of a stop work order.

1.26.07 Guarantee

The permittee, by acceptance of the permit, expressly guarantees complete performance of the work therein described and guarantees all work done by them for a period of one year after the date of completion, or other period as required by the applicable permit or agreement. The permittee agrees upon demand to maintain and to make all necessary repairs during the warranty/maintenance period, and to hold harmless the CITY for any and all claims arising from such work. This guarantee shall include all repairs and actions needed as a result of:

(A) Defects in workmanship or materials

(B) Settling of fills or excavations

(C) Failures caused by unknown reasons

(D) Any unauthorized deviations from the approved PLANS and specifications

(E) Failure to barricade

(F) Failure to clean up during and after performance of work

(G) Failure of pavement patches

(H) Any other violation of these STANDARDS AND SPECIFICATIONS.

If repairs are required during the subsequent warranty period, those repairs need only be guaranteed until the end of the initial period starting with the date of initial completion. However, in the event the CITY ENGINEER deems that the repairs are severe enough to constitute a reconstruction it may require that a new guarantee be provided for subsequent repairs after the completion of the reconstruction.

The permittee shall be responsible for providing materials and construction methods complying with these STANDARDS AND SPECIFICATIONS. If the permittee defaults in completion or conformance with these STANDARDS AND SPECIFICATIONS, the CITY ENGINEER shall submit a letter to the

permittee describing the default or non-conformance at least 10 days prior to authorizing CITY personnel to perform suitable repairs and reconstruction. The CITY ENGINEER shall be authorized to remove and replace non-conforming work and/or materials to a reasonable distance beyond the limits of the non-conforming work as required to produce a suitable repair. The permittee shall be responsible for all costs incurred by the CITY to accomplish the WORK in a safe and timely manner.

1.26.08 Performance

(A) **Inspection.**

There shall be a minimum of two inspections for each permit. The first shall occur upon notification by the CONTRACTOR that the work is ready for inspection and the second inspection will be made 30 days prior to the expiration of the warranty period. At any time prior to completion of the warranty period, the CITY ENGINEER may notify the permittee of any needed repairs. Such repairs shall be completed within 24 hours if the defects are determined by the CITY ENGINEER to be an imminent danger to the public health, safety, and welfare. Non-emergency repairs shall be completed within 10 days after notice.

(B) **Barricading and Traffic Control.**

1. All work within a traveled public roadway area shall be protected at all times by safety devices as prescribed by the MUTCD and in such manner as to minimize the disruption of the flow of traffic in the vicinity of the work. Traffic must be provided a minimum lane width of 10 feet in the construction area. Any plan for traffic control during construction must be approved by the Traffic Engineer prior to issuance of permit. Plans that indicate complete closures must show detour routes and must be approved by the Traffic Engineer at least one week prior to the issuance of the permit. The CITY reserves the right to require longer lead times if it deems necessary.

2. All work within the roadway shall take place between 8:30 a.m. and 3:30 p.m. unless otherwise stipulated on the PERMIT.

3. Street excavations must be backfilled or otherwise covered as allowed by the CITY ENGINEER prior to leaving the site at the end of the work day, even if the work has not been completed.

4. No person shall dig or cause to be dug any hole, drain, ditch, or any other excavation in any street, alley, sidewalk, or other public place within the CITY without providing sufficient amber lights to be placed with a suitable barricade or temporary fence

around such hole, drain, or other excavation in order to prevent persons, animals, and vehicles from sustaining injury. During the daytime the barricades shall be maintained but warning lights are not required. All barricades and lights shall be left in place until a permanent patch or temporary cold-mix patch can be made to the excavation.

(C) **Removal of Safety Devices or Barricades.**

No person shall damage, displace, remove, or interfere with any barricade warning light or any other safety device which is lawfully placed around or about any street, alley, sidewalk, or other excavations or construction work in the CITY.

1.27.00 OTHER PERMITS

This section discusses only those PERMITS and IMPROVEMENT AGREEMENTS which may be required by the CITY as part of the construction of the PUBLIC IMPROVEMENTS or PRIVATE IMPROVEMENTS in areas of common ownership (for example; landscaping, parking lots, etc.). It does not address other CITY PERMITS (for example; building permits, tap permits, floodplain development, etc.) or permits which may be required by other government entities (for example; CDOT, FEMA, EPA, etc.).

1.27.01 Land Disturbance Permit

The fee for this permit shall be as established by CITY CODE. This permit is required in accordance to CITY CODE 8-11-5. It should be noted that the CITY is under no obligation to issue a land disturbance permit prior to the execution of the public improvements agreement. However, if the CITY has approved the Official Development Plan, completed at least one review of the construction drawing package, and believes that the necessary revisions to that package are minor and that the review process is progressing in an acceptable manner, the CITY may issue a land disturbance permit for grading operations and erosion control. In addition, the OWNER will be required to sign a LAND DISTURBANCE AGREEMENT and provide sufficient surety for temporary and permanent BMPs. Prior to the issuance of a land disturbance permit, all provisions of Section 1.29.02 of these STANDARDS AND SPECIFICATIONS shall be complied with.

1.27.02 Temporary Water Service

All water used in the CITY for construction purposes is to be metered and charged to the user. The application for temporary water service shall be made at the CITY's Utility Division. The application and fee for each temporary meter shall be in accordance with title 8-7-11 of the CITY CODE. A deposit must be made to the CITY when the application is made. The deposit will be refunded to the applicant, less water usage charges and any consequential damages to the CITY provided equipment, once certification of water usage

has been made. In such cases where water usage charges and equipment damages exceed the deposited amount, additional charges will be billed to the applicant. Water usage rates are established by 8-7-7, Water Rate Schedule, Multiple Units, Commercial and Public of the CITY CODE. In the event a water metering device cannot be provided to the applicant by the CITY, other means will be established by the CITY to estimate water usage.

1.28.00 SUSPENSION OR REVOCATION OF PERMITS -- STOP WORK ORDER

Any PERMIT may be revoked or suspended by the CITY and a stop work order may be issued after notice to the permittee for:

(A) Violations of any condition of the Public Improvements Agreement, or of the approved construction drawings or specifications; or

(B) Violation of any provision of these STANDARDS AND SPECIFICATIONS; or

(C) Violation of any other ordinance of the CITY CODE, state law, or federal law pertaining to the work; or

(D) Existence of any condition or the occurrence of any act which may constitute or cause a condition endangering health, life, or safety, or serious damage to property.

A suspension or revocation by the CITY and stop work orders shall take effect immediately upon notice to the person performing the work in the field and shall remain in effect until such time as the CITY cancels the order in writing. A failure to abide by the terms of the suspension or revocation will be considered a violation of CITY CODE.

Upon receipt of a stop work order, the CONTRACTOR shall be responsible for taking such precautions as may be necessary to prevent damage to the project, prevent inconvenience or hazardous conditions for the general public, provide for normal drainage, and to erect any necessary barricades, signs, or other facilities which may be necessary or directed by the CITY ENGINEER and/or CITY.

1.29.00 IMPROVEMENTS AGREEMENT

1.29.01 Requirements

(A) Two improvement agreements are required: One addressing "PUBLIC IMPROVEMENTS" and one addressing "PRIVATE IMPROVEMENTS". These agreements specify the nature of all public and/or private improvements, the time frame for construction and, in standard format, identifies the obligations of the DEVELOPER/OWNER and the City of Westminster. This contract binds the owners of property being developed and any successors, assignees with interest to that property.

(B) A Land Disturbance Agreement is required according to 8-11-5 of the CITY CODE when a Land Disturbance Permit is required but the DEVELOPER/OWNER do not enter into a Public or Private Development Agreement with the CITY. The agreement will include a financial guarantee for completion of the land disturbance activities and be completed on the CITY standard template.

(C) The improvements agreement is a mandatory part of the development process and must be executed before construction activities can commence and before a final plat can be recorded. The agreement will be prepared by the City of Westminster with the information provided by the DEVELOPER/OWNER after the final construction package has been approved and will be forwarded to the DEVELOPER/OWNER for their signatures.

(D) All improvement agreements shall be completed on the CITY's standard templates. The templates shall be obtained from the CITY.

1.29.02 Surety

The IMPROVEMENTS AGREEMENTS cannot be executed nor the final plat executed and recorded until good and sufficient surety is provided by the OWNER/DEVELOPER to the CITY. The surety represents 115 percent of the total estimated cost of all public improvements and private improvements in areas of common ownership with respect to a specific project. Two separate sureties are required, one for public improvements and one for private improvements.

(A) **Types of Surety.**

There are four types of surety that the CITY will accept:

1. A letter of credit from an FDIC-insured financial institution in the state of Colorado acceptable to the CITY that guarantees the monies stated in the letter of credit on the standard CITY template.

2. Performance bonds on the standard CITY template.

3. Cash

4. A plat restriction (with approval of the CITY ENGINEER for single-family detached residential developments only).

(B) **Reduction of Surety.**

A request for reduction in surety must be made in writing to the CITY and must include an itemized cost breakdown in the same format as that included in the exhibit of the improvements agreement. Requests for reduction may only be made a maximum of two times through the duration of a project from NTP through warranty.

- One 50% reduction may be allowed once at least half of the project has been completed at the CITY's discretion.
- A second reduction may be allowed once the project has been accepted into the warranty period with a minimum of 15% of the total cost of the improvements retained.

Only after the CITY has responded in writing approving such a reduction can the reduction be made. At no time shall the amount of surety retained by the CITY be less than 15% of the total cost of the improvements.

1.30.00 CONSTRUCTION DRAWING SUBMITTAL REQUIREMENTS

Construction drawings shall contain the information and be in the format outlined in the development plan templates available from the CITY's Development Review website.

1.31.00 CONSTRUCTION MATERIAL SUBMITTAL REQUIREMENTS

1.31.01 General

The CONTRACTOR shall deliver photos of existing conditions, shop drawings, working drawings, product data, certificates of compliance and other information to the CITY ENGINEER required by the contract, construction drawings, improvements agreement, permit and/or these STANDARDS AND SPECIFICATIONS. The CONTRACTOR shall notify the CITY ENGINEER at the time of submittal of any information submitted that deviates from requirements.

The following sections summarize material submittal requirements by chapter of these STANDARDS AND SPECIFICATIONS. The lists may not be all inclusive. The CONTRACTOR shall provide all submittals required by the contract, construction drawings, improvements agreement, permit and/or these STANDARDS AND SPECIFICATIONS, including those not listed below.

1.31.02 Submittals for Chapter 2 – Earthwork, Erosion Control and Revegetation

ITEM	SPECIFICATIONS SECTION
Erosion and Sediment Control Plan	2.11.01
Manufactured Topsoil	2.40.02
Mulching	2.40.05
Seeding	2.40.04
Soil Amendments, Fertilizers and Compost	2.40.03
Topsoil	2.40.01
Weed Management	2.40.07
Wildflower Seeding	2.40.08

1.31.03 Submittals for Chapter 3 – Water System

ITEM	SPECIFICATIONS SECTION
Bedding Material	3.32.00
Bell Restraints	3.66.02
Blow-Off Materials	3.56.00
Bolts	Various
Casing Pipe	3.18.01
Casing Spacers	
Cathodic Protection Materials	3.62.00
Cathodic Protection Test Boxes	3.62.07
Combination Air Valves	3.65.00
Compression Couplings	3.60.07
Concrete	3.35.00
Concrete Block Supports	3.34.00
Copper	3.60.01
Corporation Stops	3.60.05
Curb Stops and Boxes	3.60.03
End Seals/Clamps	
Exterior Joint Tape	
Eye Bolts and Nuts	
Fire Hydrants	3.55.00
Fittings	3.53.00
Flowable Fill	

Grade Rings	3.57.02
Insulation Foam	3.61.03
Locator Tape	3.33.02
Manholes/Vaults	3.57.00
Meters (contact meter shop)	3.63.00
Meter Check Valves	3.63.06
Meter Pits/Lids	3.63.10
Meter Setters	3.63.08
Pipe Material	3.52.00
Pipe Lube	
Plastic Wrap	3.61.02
Ram-Nek	
Repair Clamps	3.69.00
Restraint Systems	3.66.00
Ring and Covers	3.57.02
Steps	3.57.01
Stop and Waste Materials	3.60.06
Tapping Saddles	3.60.02
Tapping Sleeves	3.60.04
Tracer Wire	3.33.02
Valves	3.54.00
Valve Boxes	3.54.04
Valve Extensions and Supports	3.54.01
Valve Supports	3.63.09
Vault Vents	3.59.00
Wax Seals	3.33.02
Wire Splice Kits	3.62.04
Zinc Caps	3.33.02

1.31.04 Submittals for Chapter 4 – Sanitary Sewer System

ITEM	**SPECIFICATIONS SECTION**
Bedding Material	4.32.00
Casing Pipe	4.33.03
Clean-out Materials	4.37.00
Concrete	4.55.01
End Seals	4.33.03
Exterior Coating	4.55.07

Exterior Joint Tape	4.55.04
Fittings	4.54.01
Flowable Fill	4.15.00
Gasketed Boots	4.38.00
Grade Rings	4.34.05
Grout	4.34.04
Interior Coating	4.55.06
Locator Tape	4.22.03
Manholes	4.55.00
Manhole Gaskets/Ram-Nek	4.55.04
Manhole Bases	4.55.03
Pipe Material	4.54.01
Ring and Cover	4.55.02
Spacers/Runners	4.33.03
Steps	4.55.01

1.31.05 Submittals for Chapter 5 – Storm Sewer System

ITEM	**SPECIFICATIONS SECTION**
Bedding Material	5.22.00
Cast-in-Place Concrete	5.24.00
Exterior Coatings	
Exterior Joint Tape	5.24.03
Flowable Fill	
Gasket Materials	5.44.01
Grade Rings	5.24.06
Grates	5.24.04
Grout	5.24.05
Infiltration/Bioretention Materials	
Inlets	5.45.00
Manholes	5.46.00
Orifice Plates	
Pipe Material	5.44.01
Precast Bases	5.24.02
Ram-Nek	5.45.04
Reinforcement	5.24.01
Ring and Cover	5.45.02
Steps	5.45.01

Trash Racks	

1.31.06 Submittals for Chapter 6 – Roadway

ITEM	SPECIFICATIONS SECTION
Aggregate Base Course	6.71.00
Anti-Strip Additives	6.72.02
Asphalt Binder	6.72.02
Asphalt Pavement Aggregate	6.72.02
Asphalt Pavement Mix Design	6.72.03
Crusher Fines Material	6.76.01
Detectable Warning Tiles	6.75.03
Herbicide Treatment	6.76.02
Hydrated Lime	6.72.02
Mineral Filler	6.72.02
Pavement Design	6.35.00
Prime Coat and Tack Coat Materials	6.72.05
Reclaimed Asphalt Pavement	6.72.02
Sidewalk Chase Materials	6.15.03
Structure Backfill	6.74.00
Subgrade Chemical Treatment Material	6.44.03
Subgrade Mechanical Treatment Material	6.44.04

1.31.07 Submittals for Chapter 7 – Concrete

ITEM	SPECIFICATIONS SECTION
Admixtures	7.32.04
Cement	7.32.01
Concrete Aggregate	7.32.02
Concrete Joint Materials	7.36.00
Concrete Mix Design	7.31.00
Curing Materials	7.34.00
Fly Ash	7.32.05
Reinforcement	7.33.00

Strength Histories	
Water for Concrete	7.32.03

1.31.08 Submittals for Chapter 8 – Traffic

ITEM	SPECIFICATIONS SECTION
Conduit	8.26.02
Conductor and Cable	8.32.01
Controller	8.38.00
Controller Cabinet	8.37.00
Emergency Vehicle Detectors	8.34.00
Illuminated Street Name Signs	8.42.01
Interconnect Cable	8.32.02
Loop Lead-In Cable	8.32.05
Loop Wire	8.32.03
Pavement Markings	8.27.04
Pedestal Pole	8.39.01
Pedestrian Push Buttons	8.35.00
Pedestrian Push Button Cable	8.32.04
Pull Boxes	8.26.03
Optical Detector Lead-In Cable	8.32.07
Traffic Control Plan	8.28.00
Sign Posts	8.41.02
Signal Heads	8.31.00
Signal Head Mounting Hardware	8.39.01
Signal Poles	8.36.01
Vehicle Detectors	8.33.00

1.31.09 Submittals for Chapter 9 – Trenching, Backfilling and Compacting

ITEM	SPECIFICATIONS SECTION
Bedding Material	9.22.00
Flowable Fill	9.24.00
Stabilization Material	9.21.00
Structure Backfill	9.23.00

1.31.10 Submittals for Chapter 10 – Street Lighting

ITEM	SPECIFICATIONS SECTION
Adaptive Control System	10.50.03
Bases	10.43.00
Burial Tape	10.26.08
Breakaway Connectors	10.48.00
Cabinets	10.50.02
Cable	10.47.00
Circuit Breakers	10.50.05
Concrete	10.43.03
Conduit	10.45.00
Contactors, Relays and Terminal Blocks	10.50.04
Flowable Fill	10.43.02
Lightning Arrestors	10.50.06
Luminaires	10.44.00
Power Supply	10.50.01
Pull Boxes	10.46.00
Splice Kits	10.49.00
Street Light Poles & Luminaire Arms	10.42.00

1.31.11 Submittals for Chapter 11 – Reclaimed Water System

ITEM	SPECIFICATIONS SECTION
Bedding Material	11.32.00
Bell Restraints	11.65.02
Bolts	Various
Cathodic Protection Materials	11.22.00
Combination Air Valves	11.64.00
Compression Couplings	11.60.07
Concrete	11.61.01
Concrete Block Supports	11.34.00
Copper	11.60.01
Corporation Stops	11.60.05
Curb Stops and Boxes	11.60.03
End Seals/Clamps	

Exterior Joint Tape	
Eye Bolts and Nuts	
Fittings	11.53.00
Flowable Fill	
Locator Tape	11.33.02
Manholes/Vaults	11.57.00
Meters (contact meter shop)	11.62.00
Meter Check Valves	11.62.06
Meter Setters	11.62.08
Pipe Material	11.52.00
Pipe Lube	
Plastic Wrap	11.61.02
Ram-Nek	11.57.04
Repair Clamps	11.68.00
Restraint Systems	11.65.00
Ring and Covers	11.57.02
Steps	11.57.01
Stop and Waste Materials	11.60.06
Tapping Saddles	11.60.02
Tapping Sleeves	11.60.04
Tracer Wire	11.33.02
Valves	11.54.00
Valve Boxes	11.54.04
Valve Extensions and Supports	11.54.01
Valve Supports	11.62.09
Vault Vents	11.59.00
Wax Seals	11.33.02
Wire Splice Kits	11.22.00
Zinc Caps	11.33.02

TABLE OF CONTENTS

CHAPTER 2
GENERAL REQUIREMENTS

Page

2.00.00 EARTHWORK AND GRADING 2-1

2.10.00 EROSION CONTROL **2-1**

2.10.01 Limitations 2-2
2.10.02 Exemptions 2-2
2.10.03 Responsibility 2-3
2.10.04 Regulations 2-3

2.11.00 EROSION AND SEDIMENT CONTROL PLANS 2-3
2.12.00 STORMWATER MANAGEMENT PLANS (SWMP) 2-88

2.20.00 REVEGETATION **2-8**

2.20.01 Topsoil 2-8
2.20.02 Preparation 2-8
2.20.03 Seeding 2-99
2.20.04 Mulching 2-99
2.20.05 Irrigation 2-9
2.20.06 Weed Management 2-9
2.20.07 Wildflower Introduction 2-9

2.30.00 CONSTRUCTION 2-9

2.30.01 Topsoil 2-9
2.30.02 Grading Preparation 2-1010
2.30.03 Amendments, Fertilizers & Compost 2-10
2.30.04 Seeding 2-111
2.30.05 Mulching 2-11
2.30.06 Temporary Irrigation 2-12
2.30.07 Weed Management 2-12
2.30.08 Wildflower Introduction 2-133

2.40.00 MATERIALS 2-133

2.40.01 Topsoil 2-133
2.40.02 Manufactured Topsoil 2-13
2.40.03 Amendments, Fertilization, Compost 2-13
2.40.04 Seeding 2-15
2.40.05 Mulching 2-16
2.40.06 Irrigation 2-16
2.40.07 Weed Management 2-177
2.40.08 Wildflower Seeding 2-17

CHAPTER 2
EARTHWORK, EROSION CONTROL, AND REVEGETATION

2.00.00 EARTHWORK AND GRADING

All earthwork operations shall be executed in a manner which will minimize dust, noise, excessive accumulation of debris, danger to the public, and interference with other construction. Positive drainage and adequate erosion control shall be provided at all times during the earthwork operations.

Earthwork operations shall be executed to provide compaction to a minimum 85-percent Standard Proctor density at ± 3 percent of optimum moisture in areas to be eventually turfed or planted and compaction to minimum 95 percent Standard Proctor density at ± 2 percent of optimum moisture under all walks, trails, streets, structures, and other site improvements. Testing, if required by the CITY to demonstrate compliance with this specification, shall be performed per AASHTO T-180 by a Professional Engineer registered in the State of Colorado and practicing in the field of soils mechanics. All costs for such testing shall be paid by the CONTRACTOR/DEVELOPER. Refer to the applicable section in these STANDARDS AND SPECIFICATIONS for compaction requirements within the public right-of-way.

Upon completion of earthwork operations, the CONTRACTOR shall leave the site and soil clean to allow for proper installation of irrigation, plantings, and related site improvements. Completed grades shall be smoothly and uniformly sloped, properly compacted, and shall provide drainage away from site improvements. All banks or slopes constructed shall be maintained in a stable condition by approved methods to prevent slips, washouts, or erosion. No area to be seeded or sodded shall be steeper than a 4:1 maximum slope (4 horizontal: 1 vertical), nor flatter than a 2-percent minimum slope. Final grades shall conform to the Final Drainage Study and Grading Plans.

2.10.00 EROSION CONTROL

The primary goal of erosion control is to reduce and/or prevent movement of eroded soil sediments offsite to promote the safety, health, and general welfare of the public. Selection of the proper erosion control measures must consider the magnitude and type of erosion specific to the site, as well as the resources available for implementation. To address proper erosion control measures, a site Erosion and Sediment Control Plan shall be designed and implemented for every site that requires a Land Disturbance Permit to be in regulatory compliance.

There are two major elements in developing an Erosion and Sediment Control Plan. The first is an investigation and analysis of the natural characteristics of a site (such as soil type, steepness of slopes, and available vegetation) that will

help the developer anticipate where erosion problems might occur. Detailed information on soils, vegetation, topography, geologic, and hydrologic conditions shall be obtained for the site. The second element is use of effective control measures. Attention shall be given to identify and evaluate problems that may cause serious erosion during and after construction. Runoff from the site, as well as runoff from the watershed above, shall be controlled and discharged safely. Measures shall be taken to prevent erosion and sediment deposition on downstream properties.

2.10.01 Limitations

No person shall clear or grade land without implementing soil erosion and sediment controls in accordance with the requirements of these STANDARDS AND SPECIFICATIONS, and the CITY CODE. Any grading, stripping, excavating, filling or otherwise disturbing of land within the CITY limits shall comply with the CITY CODE, an IMPROVEMENTS AGREEMENT, an approved Land Disturbance Permit and the CDPHE Water Quality Control Division's Construction Stormwater Discharge Permit Regulations.

A Land Disturbance Permit in accordance with CITY CODE Section 8-11-5 shall be obtained by the OWNER or CONTRACTOR when there is not an IMPROVEMENTS AGREEMENT in place for the work and any of the following applies:

(A) The grading covers an area equal to or greater than one acre, or

(B) The grading covers an area less than one acre if the site is part of a larger common plan of development, or

(C) The grading involves earthwork affecting more than 200 cubic yards of material, or

(D) The work occurs in environmentally sensitive areas, as determined by the CITY MANAGER, or

(E) The grading is on any property that possesses physical characteristics or features that increase the potential for erosion, such as highly erodible soils, natural drainage channels or swales, or slopes in excess of eight percent.

2.10.02 Exemptions

(A) Agricultural land management practices;

(B) Clearing or grading activities that are subject exclusively to State approval and enforcement under State law and regulations.

2.10.03 Responsibility

Any person who undertakes or is responsible for undertaking any activity which involves any land disturbance is ultimately responsible for controlling soil erosion, sedimentation, and water flow characteristics to the extent necessary to avoid damage to property and the pollution of public waters. Nothing in the DRAINAGE CRITERIA MANUAL shall be taken or construed as lessening or modifying the ultimate responsibility of such persons nor do the requirements of the DRAINAGE CRITERIA MANUAL imply the assumption of any liability on the part of the CITY. The DRAINAGE CRITERIA MANUAL does not relieve such person's responsibility to provide effective control measures.

2.10.04 Regulations

Any grading, stripping, excavating, filling or otherwise disturbing of land within the CITY limits shall comply with the CITY CODE, these STANDARDS AND SPECIFICATIONS, and CDPHE Water Quality Control Division's Construction Stormwater Discharge Permit regulations.

2.11.00 EROSION AND SEDIMENT CONTROL PLANS

2.11.01 Requirements

(A) A person may not clear or grade land without first preparing an Erosion and Sediment Control Plan which has been approved by the CITY and then acquiring a Land Disturbance Permit.

(B) Developers are required to develop site plan(s) that locate (if applicable) and identify all structural and non-structural control measures for the applicable construction activities.

The site plan(s) must contain installation and implementation specifications or a reference to the document with installation and implementation specifications for all structural control measures. A narrative description of non-structural control measures must be included in the site plan(s).

(C) The Erosion and Sediment Control Plan shall be prepared electronically at a scale no smaller than 1 inch equals 100 feet and shall contain, but not be limited to the following information:

1. Vicinity Map
2. Site boundary based upon a legal survey
3. Legal description and size of parcel being graded

4. Existing topography of the property and at least 150 feet beyond the property boundaries with a maximum contour interval of 2 feet.
5. Proposed topography with a maximum contour interval of 2 feet.
6. Proposed grading limits.
7. Identification of proposed steep slopes both temporary and permanent.
8. Identification of existing and proposed swales, ditches and drainageways.
9. Proposed surface improvements (i.e. roads, detention ponds, storm sewers).
10. Location of the soil stockpiles with the anticipated height, width and length as well as the limits for the stockpiles.
11. Location of the proposed erosion and sediment control measures.
12. Details of the proposed erosion and sediment control measures.
13. Other details or requirements that may be necessary to ensure compliance with the Federal Water Pollution Control Act.
14. General notes as specified in Chapter 2 of these STANDARDS AND SPECIFICATIONS.
15. The following note shall be included on all Erosion and Sediment Control Plans: "This Erosion and Sediment Control Plan Erosion and Sediment Control Plan has been submitted to the CITY of Westminster and is in general conformance with the CITY's Standards and Specifications. Additional erosion and sediment control measures may be required of the owner and his or her agents due to unforeseen erosion problems or if the proposed erosion control measures do not function as intended. The requirements of this Erosion and Sediment Control Plan and the obligation of the land owner shall run with the land until such time as the Erosion and Sediment Control Plan is properly completed, officially modified, or voided".
16. All Erosion and Sediment Control Plans shall include a signature block for the property owner stating the following: "I, (property owner's name), have reviewed the CITY's Standards and Specifications and this Erosion and Sediment Control Plan. I acknowledge my responsibility to provide all necessary erosion and sediment control measures to avoid damage to property and polluting of receiving waters."
17. All Erosion and Sediment Control Plans shall include a signature block for the design engineer acknowledging responsibility for the preparation of the Erosion and Sediment Control Plan. All plans shall be prepared by or under the

direction of a Professional Engineer registered in the State of Colorado.

(D) The applicant shall submit an Erosion and Sediment Control Plan and any supporting computations to the CITY for review and approval. The Erosion and Sediment Control Plan shall contain sufficient information, drawings, and notes to describe how soil erosion and off-site sedimentation will be minimized. The CITY shall review the plan to determine compliance with these STANDARDS AND SPECIFICATIONS and the CITY CODE prior to approval. The plan shall serve as a basis for all subsequent grading and stabilization.

(E) In approving the plan, the CITY may impose such conditions thereto as may be deemed necessary to ensure compliance with the provisions of these STANDARDS AND SPECIFICATIONS for the preservation of public health and safety.

(F) The Erosion and Sediment Control Plan shall not be considered approved without the inclusion of the signature and date of signature of the CITY ENGINEER.

(G) Approved plans may remain valid for one year from the date of approval unless renewed by the CITY.

(H) Approved plans will become an exhibit to the CITY's Land Disturbance Permit. In addition, the DEVELOPER/CONTRACTOR will be required to execute an improvements agreement and provide surety in a form outlined by CITY CODE prior to beginning earthwork operations.

(I) Control measures must be selected, designed, installed, implemented, and maintained to provide control of all potential pollutants, such as but not limited to sediment, construction site waste, trash, discarded building materials, concrete truck washout, chemicals, sanitary waste, and contaminated soils in discharges to the MS4. At a minimum, pollutant sources associated with the following activities (if part of the applicable construction activity) must be addressed:

- Land disturbance and storage of spoils
- Vehicle tracking
- Loading and unloading operations
- Outdoor storage of construction site materials, building materials, fertilizers, and chemicals
- Bulk storage of materials
- Vehicle and equipment maintenance and fueling
- Significant dust or particulate generating processes

- Routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents and oils
- Concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment
- Dedicated asphalt and concrete batch plants
- Other areas or operations where spills occur
- Other non-stormwater discharges including construction dewatering not covered under the Construction Dewatering Discharges general permit and wash water that may contribute pollutants to the MS4. Ensuring proper fastening of port-o-lets

2.11.02 Modifications to Approved Erosion and Sediment Control Plans

When inspection of the site indicates the approved Erosion and Sediment Control Plan needs modification, the modification shall be made in compliance with the erosion and sediment control criteria contained in these STANDARDS AND SPECIFICATIONS, the DRAINAGE CRITERIA MANUAL, and the CITY CODE.

(A) The permittee shall submit requests for major modifications to approved Erosion and Sediment Control Plans, such as hydrological changes like the addition or deletion of a sediment basin, to the CITY to be processed appropriately.

(B) The CITY may approve minor modifications, including any temporary stormwater control measures, to approved Erosion and Sediment Control Plans in the field if conditions so merit. If the control measures differ from the CITY's Standard Erosion Control details, specifications must be submitted to the CITY INSPECTOR and included in the Erosion and Sediment Control Plan and/or Stormwater Management Plan (SWMP).

2.11.03 Grading and Erosion Control Notes

The following minimum grading and erosion control notes shall be stated on, as well as incorporated into the overlot grading and Erosion and Sediment Control Plan:

GRADING AND EROSION CONTROL NOTES

(A) All site grading (excavation, embankment, and compaction) shall conform to the recommendations of the latest soils investigation for this property and shall further be in conformance with the CITY of Westminster's "STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS," latest edition.

(B) Natural vegetation shall be retained and protected wherever possible. Exposure of soil to erosion by removal or disturbance of vegetation shall be limited to the area required for immediate construction operation and for the shortest practical period of time.

(C) Topsoil shall be stockpiled to the extent practicable on the site for use on areas to be revegetated. Any and all stockpiles shall be located and protected from erosive elements.

(D) Temporary vegetation shall be installed on all disturbed areas where permanent surface improvements are not scheduled for installation within 14 days. Vegetation shall be a vigorous, drought tolerant, native species mix. (Refer to Section 2.40.04 of these STANDARDS AND SPECIFICATIONS for seeding mix.) Project scheduling should take advantage of spring or fall planting seasons for natural germination, but seeded areas shall be irrigated, if conditions so merit.

(E) At all times, the property shall be maintained and/or watered to prevent wind-caused erosion. Earthwork operations shall be discontinued when fugitive dust significantly impacts adjacent property. If earthwork is complete or discontinued and dust from the site continues to create problems, the owner/developer shall immediately institute mitigative measures and shall correct damage to adjacent property.

(F) Temporary cut/fill slopes shall not exceed a steepness of 2:1 (2H:1V). Permanent slopes shall not exceed 4:1 (4H:1V) in areas to be seeded or sodded.

(G) Utility construction is not approved under this plan.

(H) The OWNER/DEVELOPER shall provide any additional dust abatement and erosion control measures deemed necessary by the CITY, should conditions merit them.

(I) Temporary fences shall be installed along all boundaries of the construction limits or property lines as shown on the approved Erosion and Sediment Control Plan, to prevent grading on property not owned by the developer. In addition, the CITY may require additional temporary fences if field conditions so merit them.

2.11.04 Standard Erosion Control Details

In the Appendix of these STANDARDS AND SPECIFICATIONS are the standard erosion control details which are acceptable to the CITY. The CITY may accept other proposed BMP products upon review and approval by the CITY ENGINEER.

2.12.00 STORMWATER MANAGEMENT PLANS (SWMP)

Any land disturbance that disturbs more than an acre of land or under an acre that is part of a larger development will require a State Construction Stormwater General Permit along with the preparation of a SWMP.

(A) **Land Disturbance Permits will not be issued by the CITY without acquiring a CDPHE Water Quality Division's Construction Stormwater General Permit.**

(B) All SWMP's are subject to standards set by CDPHE Water Quality Division's Stormwater Construction General Permit.

(C) The CITY will review Stormwater Management Plans to ensure compliance with the standards set by CDPHE Water Quality Division's Construction Stormwater General Permit.

2.20.00 REVEGETATION

For the purpose of this chapter, the term "revegetation" refers to ground cover only. "Formal" landscaping requirements are specified in a separate document titled CITY of Westminster Landscape Regulations. Final drawings, specifications, and details shall be submitted to the CITY for review and approval prior to construction.

2.20.01 Topsoil

Areas to be revegetated shall be prepared with topsoil and soil preparation amendments. The CITY has the prerogative of deleting all or a portion of the soil preparation requirements when topsoil is imported, depending on topsoil quality and quantity. Topsoil amendments shall meet the requirements of these STANDARDS AND SPECIFICATIONS.

2.20.02 Preparation

Soil preparation amendments shall be provided on all areas to be seeded, sodded, or otherwise planted.

2.20.03 Seeding

Areas to be revegetated shall utilize seeding in the mixes according to these STANDARDS AND SPECIFICATIONS. The mix to be utilized will vary depending on the location (open space versus trailside/roadside) and shall be specified in the PLANS.

2.20.04 Mulching

Mulch is required on seeded areas and is utilized to conserve moisture, prevent crusting, reduce runoff and erosion and help establish a plant cover.

2.20.05 Irrigation

Irrigation, whether temporary or permanent, is required to establish the revegetation for the duration of the agreement with the CITY.

2.20.06 Weed Management

Following seeding, weed management is required for all seeded areas until final acceptance of the project by the CITY. Eradication method shall be approved by the CITY ENGINEER.

2.20.07 Wildflower Introduction

After the first year of broadleaf weed abatement is complete, wildflower over-seeding is required. Seeding must be done in the spring (March through May) prior to the second summer growing season.

2.30.00 CONSTRUCTION

2.30.01 Topsoil

Areas to receive topsoil shall be scarified to a 6-inch depth to improve the bond of topsoil to subsoil. Place topsoil to a minimum depth of 6-inches after settlement. Spread evenly and grade to elevations and slopes shown on the approved ODP or PLANS. Hand rake areas inaccessible to machine grading.

If sufficient on-site material is not available, the CONTRACTOR shall furnish and install imported topsoil in the manner described above. Topsoil shall be mixed thoroughly with the salvaged topsoil prior to placement.

Utilize manufactured topsoil as the top layer, placing over scarified subgrade to a depth of 6-inches.

Protect completed areas where topsoil has been spread from traffic to prevent compaction. Any areas that, as determined by CITY ENGINEER, become

compacted due to the CONTRACTOR's construction traffic shall be reconstructed.

2.30.02 Grading Preparation

The surface shall be graded to finished elevations per approved ODP or PLANS. No ponding water will be allowed and shall be corrected.

2.30.03 Amendments, Fertilizers & Compost

The CONTRACTOR shall submit bag tags and/or truck load tickets for all products. The
CONTRACTOR shall apply one or more of the following as directed by the CITY ENGINEER:

(A) Apply Biosol organic slow-release fertilizer at a rate of 1000 lbs. per acre per manufacturer's recommendation.

(B) Apply Earthgreen Menefee Humate All Natural Organic Soil Conditioner at a rate of 250 lbs. per acre per manufacturer's recommendation.

(C) Apply AM-120 Standard mycorrhizal inoculum at a rate of 60 lbs. per acre per manufacturer's recommendation.

(D) Apply Triple superphosphate at a rate of 1000 lbs. per acre.

(E) Compost shall be evenly spread over the entire surface at the rate of 4 cubic yards per 1,000 square feet (approximately 1-1/2" depth).

Upon establishment of approved grades, the soil surface shall be loosened by rototilling to a minimum of 8 inches (for a 20% to 30% inclusion rate), and all materials over 2 inches in diameter shall be removed and the soil surface shall be reasonably free of large clods, roots, and stones greater than 2 inches, and other material which will interfere with seeding and subsequent site maintenance. Higher inclusion rates are necessary for upgrading marginal soils, as determined by the CITY ENGINEER. All amendments, fertilizers and compost shall be mixed thoroughly into the soil surface to a depth of 8 inches by means of a rototiller, soil mixer or similar equipment. Do not leave mycorrhizal inoculum exposed to sunlight for more than four hours. The surface shall then be finish-graded, compacted to the approved elevations and the soil surface shall be raked smooth prior to seeding.

Seeding shall take place within 48 hours of soil preparation, unless otherwise approved by the CITY
ENGINEER.

2.30.04 Seeding

See seeding mix in Section 2.40.04 for seeding application rates. Seeding shall be hydroseeded unless otherwise approved by the CITY ENGINEER. Areas larger than 1 acre with slopes of 3:1 or flatter may be drill seeded and areas with slopes greater than 3:1 may be hand broadcast, if approved by the CITY ENGINEER. The CONTRACTOR shall submit seed bag tags for all seeding methods.

Hydroseeding shall occur as a separate process prior to hydromulching. Do not mix seed and mulch together in one slurry application process.

If approved by the CITY ENGINEER, seed may be drill seeded. Mechanical power-drawn drills shall have depth bands set to maintain a planting depth between ¼ inch and ½ inch and shall be set to space the rows not more than 2 inches apart. In addition, the drill shall be equipped with multiple seed boxes from which large smooth, small smooth, and appendaged (i.e. fluffy or trashy) seed can be metered evenly. Seed that is extremely small shall be sowed from a separate hopper adjusted to the proper rate of application. Seed shall not be drilled or sown during windy weather or when the ground is frozen or otherwise untillable. If inspections indicate that strips wider than the specified space between the rows planted have been left or other areas skipped, the CITY may require immediate resowing of seed in such areas at the developer's expense. During all seeding operations, proper functioning of the seed drill will be demonstrated to the satisfaction of the CITY upon request.

If approved by the CITY ENGINEER, seed may be hand or mechanical broadcasted. Hand method of broadcasting seed will be permitted only on small areas not accessible to machine methods. All seed sown by broadcast-type seeders shall be "raked in" or otherwise covered with soil to a depth of at least 1/4-inch.

The minimum standard for any dryland grass is 8 seedlings of the seeded species per square foot. If requested by the CITY, this count/inspection shall be taken four (4) weeks after germination by a qualified botanist. Any area not meeting the specifications on germination will be touch up seeded in one of the following methods:

(A) Hand Broadcast and Incorporation

(B) Mechanical Broadcast and Incorporation

(C) Interseeding with Seed Drilling Equipment

Water thoroughly after seeding.

2.30.05 Mulching

Mulching material shall be applied immediately after seeding.

For hydroseeding, slurry mix shall not be combined with hydroseeding. Apply hydro-mulch (wood fibers in a water slurry) at a minimum rate of 2,000 lbs/acre with a guar gum tackifier.

For drill-seeded areas: Grain straw shall be used at an application rate of 4,000 lbs/acre of air-dried material. At least 50-percent of the mulch by weight shall be 10 inches or more in length. Mulch shall be anchored immediately after distributing with a mulch crimper and tackifier.

For steep slopes hand or mechanical broadcasted:

(A) Mulch netting shall be firmly held in place with pins spaced not more than ten linear feet apart. In sandy or extremely loose soil, the pins shall be located not more than 5 linear feet apart.

(B) Jute netting or similar approved materials shall be installed according to the manufacturer's recommendations.

(C) Excelsior mat shall be installed according to the manufacturer's recommendations.

2.30.06 Temporary Irrigation

All disturbed areas shall be irrigated temporarily by a method approved by the CITY. Water and irrigation plan shall be approved by the CITY. Temporary irrigation shall remain in place for a period of at least one growing season or until the WORK has been accepted out of WARRANTY, whichever time period is longer. All irrigation piping must be buried, including drip or bubbler tubing to trees and shrubs. Removal or discontinuation of temporary irrigation shall be approved by the CITY. Tap fees and water costs used for the establishment of seed are to be paid by the OWNER or DEVELOPER.

Any and all repairs of the temporary irrigation system are the responsibility of the OWNER or DEVELOPER through the life of the IMPROVEMENTS AGREEMENT. Such repairs are to be completed by the DEVELOPER in a timely manner.

2.30.07 Weed Management

Manual control will be undertaken where species and circumstances allow. Chemical treatment may become necessary in some areas. Eradication method must be approved by the CITY ENGINEER.

2.30.08 Wildflower Introduction

See wildflower mix in Section 2.40.08 for seeding application rates. Wildflower seeding shall be hand or mechanical broadcast. Water thoroughly after seeding.

2.40.00 MATERIALS

2.40.01 Topsoil

All imported topsoil shall be a loam or sandy loam conforming to ASTM D 5268. At least 10 days prior to topsoil delivery, notify the CITY ENGINEER of the source(s) from which topsoil is to be furnished. Topsoil shall be furnished by the CONTRACTOR and shall be a natural, friable soil representative of productive soils and shall meet the following conditions. Topsoil shall be free from weeds, sod, and material larger than 1-inch, toxic substances, litter or other deleterious material. The topsoil shall have an acidity in the range of pH 6.5 to pH 8.5, and shall be screened and meet the following mechanical analysis:

	% PASSING	% RETAINED
1 Inch Screen	100	0
1/2 Inch Screen	97-100	0-3
#100 Mesh Sieve	60-40	40-60

Soil Texture:
Sand: 30% - 50%
Silt: 30% - 50%
Clay: 5% - 30%

Soluble Salts: Electric conductivity (EC) shall be less than 2.0 mmhos/cm for turfgrass areas, dryland areas, and planting beds.

2.40.02 Manufactured Topsoil

"Amended Topsoil" as manufactured by A1 Organics, 16350 WCR 76, Eaton, CO 80615 Ph: (970) 4543492, (800) 776-1644 Fax: (970) 454-3232 www.a1organics.com, or substitution as approved by the CITY ENGINEER.

2.40.03 Amendments, Fertilization, Compost

(A) Organic slow-release fertilizer (6-1-1, NPK): Biosol, or CITY approved equal.

(B) Natural soil conditioner: Earthgreen Menefee Humate All Natural Organic Soil Conditioner, or CITY approved equal.

(C) Mycorrhizal inoculum: AM-120 Standard, or CITY approved equal.

(D) Triple superphosphate (P2O5 with an N-P-K of 0-46-0)

(E) If a soil analysis indicates sufficient amounts of the above elements the CITY may, at its discretion, waive the requirement to fertilize.

(F) Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from: agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; source-separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. The product shall be certified through the U.S. Composting Council's (USCC) Seal of Testing Assurance (STA) Program.

Product Parameters*:

Parameters1,6	**Reported as (units of measure)**	**General Range**
pH	pH units	6.0 - 7.5
Soluble Salt Concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 5
Moisture Content	%, wet weight basis	30 – 60
Organic Matter Content	%, dry weight basis	30 – 65
Particle Size	% passing a selected mesh size, dry weight basis	98% pass through 3/4" screen or smaller
Stability Carbon Dioxide Evolution Rate	mg CO_2-C per g OM per day	< 2
Maturity Indicator	Carbon to Nitrogen Ratio (C/N)	<12
Maturity Indicator	Ammonia N / Nitrate N Ratio	< 4
Maturity (Cucumber Bioassay) Seed Emergence and Seeding Vigor (each)	%, relative to positive control (each)	Minimum 80% (each)

Parameters1,6	Reported as (units of measure)	General Range
Maturity (Red Clover lopyralid Sensitive Plants-Bioassay) Seed Emergence and Seed Vigor (each)	%, relative to positive control (each)	Minimum 80% (each)
Physical Contaminants (inerts)	%, dry weight basis	<
Chemical Contaminants[2]	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 & 3 levels
Biological Contaminants[3] (Select Pathogens: Fecal Coliform Bacteria, or Salmonella)	MPN per gram per dry weight MPN per 4 grams per dry weight	Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels

Notes:

[1] Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, The US Composting Council)

[2] US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels = Arsenic 41ppm, Cadmium 39ppm, Copper 1,500ppm, Lead 300ppm, Mercury 17ppm, Molybdenum 75ppm, Nickel 420ppm, Selenium 100ppm, Zinc 2,800ppm.

[3] US EPA Class A standard, 40 CFR § 503.32(a) levels = Salmonella <3 MPN/4grams of total solids or Fecal Coliform <1000 MPN/gram of total solids.

[4] CITY landscape architects and project engineers may modify the allowable compost specification ranges based on soil analysis, specific field conditions and plant requirements.

*Before delivery of the compost, supplier must provide a copy of the lab analysis, performed by a STA Program certified lab, verifying that the compost meets the product parameters listed above. The lab analysis should not be more than 90 days old. *Truck delivery tickets must match the approved compost.

Verifying current participation in the STA Program can also be achieved by logging onto the USCC website at www.compostingcouncil.org.

2.40.04 Seeding

(A) Open Space Mix

Grasses (Species)	Common Name	Rate-PLS lb/ac*
Bouteloua curtipendula	Sideoats Grama	13.6
Bouteloua gracilis	*Blue grama - Alma or native*	*24.8*

Buchloe dactyloides	*Buffalograss - Native*	*36.0*
Calamovilfa longifolia	*Prairie Sandreed*	*12.4*
Schizachyrium scoparium	*Little Bluestem*	*9.6*
Sporobolus airoides	*Alkali Sacaton-Native*	*1.6*

* Rate for hydroseeding; PLS = Pure Live Seed
(Bulk rate =PLS rate/(% purity x % germination).

Hydroseeding Rate:	98 PLS#/Acre
Drill Seeded Rate:	49 PLS#/Acre
Mechanical Broadcast Rate:	98 PLS#/Acre
Hand Broadcast Areas Rate:	98 PLS#/Acre

(B) Trailside Low Grow Mix – For use along trails and roadways.

Grasses (Species)	Common Name	Rate-PLS lb/ac*
Bouteloua curtipendula 'Vaughn'	Sideoats Grama	18.0
Bouteloua gracilis 'Alma'	Blue grama - Alma or native	15.0
Buchloe dactyloides 'Texoka'	Buffalograss - Native	48.0
Koeleria macrantha	Junegrass	3.6
Pascopyrum smithii 'Arriba'	Western Wheatgrass, Arriba	12.0

* Rate for hydroseeding; PLS = Pure Live Seed
(Bulk rate =PLS rate/(% purity x % germination).

Hydroseeding Rate:	96.6 PLS#/Acre
Drill Seeded Rate:	48.3 PLS#/Acre
Mechanical Broadcast Rate:	96.6 PLS#/Acre
Hand Broadcast Areas Rate:	96.6 PLS#/Acre

(C) Purity: Grass seed specified will comply with all current state regulations regarding weed seed content and will meet the required pure live seed content as adjusted for batch purity and germination.

2.40.05 Mulching

A guar-based tackifier shall be included in the hydro-mulch.

2.40.06 Irrigation

A temporary irrigation plan and materials must receive approval from the CITY ENGINEER prior to installation.

2.40.07 Weed Management

Chemical management materials must receive approval from the CITY ENGINEER prior to use.

2.40.08 Wildflower Seeding

Wildflower Mix

Species	Common Name	Rate-PLS lb/ac*
Aquilegia caerulea	Blue Columbine	9.0
Cleome serrulata	Rocky Mountain Beeplant	9.0
Coreopsis tinctoria	Plains Coreopsis	9.0
Erigeron speciosus	Fleabane Daisy	9.0
Erysimum capitatum	Western Wall Flower	9.0
Gaillardia aristata	Perennial Gaillardia	9.0
Linum lewisii	Blue Flax	14.0
Penstemon strictus	Rocky Mountain Penstemon	9.0
Ratibida columnifera	Prairie Coneflower	14.0
Rudbeckia hirta	Blackeyed Susan	9.0

* Rate for hydroseeding; PLS = Pure Live Seed (Bulk rate =PLS rate/(% purity x % germination).

Hydroseeding Rate:	100 PLS#/Acre
Drill Seeded Rate:	50 PLS#/Acre
Mechanical Broadcast Rate:	100 PLS#/Acre
Hand Broadcast Areas Rate:	100 PLS#/Acre

TABLE OF CONTENTS

CHAPTER 3
WATER SYSTEM

Page

3.00.00 INTRODUCTION 3-1
3.01.00 INTERRUPTION OF SERVICE 3-1
3.02.00 WATER BREAKS 3-1
3.03.00 METER SET INSTALLATION REINSPECTION FEE 3-2
3.10.00 DESIGN CRITERIA 3-2
3.11.00 SCOPE 3-2
3.12.00 GENERAL 3-2
3.12.01 Water System Utility Study Requirements 3-2
3.13.00 DESIGN DEMAND 3-4
3.14.00 HYDRAULIC DESIGN 3-6
3.15.00 OPERATING PRESSURES WITHIN THE DISTRIBUTION SYSTEM 3-7
3.16.00 PRESSURE REGULATING STATIONS 3-7
3.17.00 SIZING OF MAINS 3-8
3.17.01 Distribution Mains 3-8
3.17.02 Transmission Mains 3-8
3.18.00 SYSTEM LAYOUT – CONSTRUCTION PLAN CRITERIA 3-8
3.18.01 General 3-8
3.18.02 Waterline Crossing Over A Sanitary Sewer Line 3-9
3.18.03 Waterline Crossing Over A Storm Sewer Line 3-10
3.18.04 Sanitary Sewer Line Crossing Over A Waterline 3-10
3.18.05 Storm Sewer Line Crossing Over A Waterline 3-11
3.18.06 Limits on Vertical Separation 3-11
3.18.07 Combination Air Valves 3-11
3.19.00 EASEMENTS 3-11
3.20.00 FUTURE CONNECTIONS 3-12
3.21.00 SERVICES 3-12
3.22.00 TRANSMISSION MAINS 3-13
3.23.00 UNLAWFUL CONNECTION 3-14
3.24.00 APPURTENANCES 3-14
3.24.01 Valves 3-14
3.24.02 Fire Hydrants 3-15
3.24.03 Thrust Blocks and Joint Restraint Devices 3-15
3.24.04 Meters 3-16
3.24.05 Fire Protection Service Line 3-17
3.24.06 Valve Vaults 3-17
3.24.07 Manholes 3-17
3.24.08 Backflow Prevention Assemblies 3-17
3.30.00 CONSTRUCTION SPECIFICATIONS 3-18
3.31.00 TRENCHING, BACKFILLING AND COMPACTION 3-18
3.32.00 BEDDING 3-18
3.33.00 PIPELINE INSTALLATION 3-18
3.33.01 General 3-18
3.33.02 Pipe 3-19
3.33.03 Fittings 3-20

3.34.00 VALVE AND VALVE BOX INSTALLATIONS 3-21
3.35.00 THRUST BLOCKS 3-21
3.36.00 CONNECTION TO EXISTING MAINS 3-22
3.37.00 FIRE HYDRANT INSTALLATION 3-22
3.38.00 TAPS 3-23
3.39.00 METER INSTALLATION 3-24
3.39.01 3/4-Inch and 1-Inch Meter Installations *3-25*
3.39.02 1-1/2-Inch and 2-Inch Meter Installations *3-25*
3.39.03 3-Inch and Larger Meter Installations *3-26*
3.40.00 TESTS 3-27
3.40.01 General *3-27*
3.40.02 Filling and Venting Lines *3-27*
3.40.03 Disinfection *3-27*
3.40.04 Flushing the Main *3-28*
3.40.05 Pressure Test *3-28*
3.40.06 Bacteriological and Turbidity Test *3-29*
3.40.07 Cathodic Protection System Testing *3-29*
3.41.00 WORKING WITH ASBESTOS CEMENT PIPE 3-30
3.42.00 ABANDONMENT PROCEDURES 3-30
3.50.00 MATERIALS 3-31
3.51.00 GENERAL 3-31
3.52.00 PIPE 3-31
3.52.01 Ductile Iron Pipe (DIP) *3-31*
3.52.02 Polyvinyl Chloride Pipe (PVC) *3-32*
3.52.03 Steel Pipe *3-33*
3.53.00 FITTINGS 3-33
3.54.00 VALVES 3-34
3.54.01 General *3-34*
3.54.02 Gate Valves *3-34*
3.54.03 Butterfly Valves *3-35*
3.54.04 Valve Boxes *3-36*
3.55.00 FIRE HYDRANTS 3-36
3.56.00 BLOW-OFFS 3-37
3.57.00 MANHOLES AND VAULTS 3-37
3.57.01 General *3-37*
3.57.02 Rings and Covers *3-38*
3.57.03 Base Slabs and Base Beams *3-39*
3.57.04 Joint Material *3-39*
3.57.05 Mortar *3-39*
3.58.00 VAULT ELECTRICAL AND MECHANICAL 3-40
3.59.00 VENT PIPES 3-40
3.60.00 SERVICE CONNECTIONS 3-40
3.60.01 Pipe *3-40*
3.60.02 Saddles *3-40*
3.60.03 Curb Stop Valves and Curb Stop Boxes *3-41*
3.60.04 Tapping Sleeve and Valve *3-41*
3.60.05 Corporation Stops *3-42*
3.60.06 Stop and Waste *3-43*
3.60.07 Compression Couplings *3-43*
3.61.00 ENCASEMENT 3-43
3.61.01 Concrete *3-43*
3.61.02 Polyethylene Encasement *3-43*

3.61.03 Extruded Polystyrene Insulating Foam *3-44*
3.62.00 CATHODIC PROTECTION 3-44
3.62.01 General *3-44*
3.62.02 Sacrificial Anodes *3-44*
3.62.03 Wire Conductors *3-45*
3.62.04 Wire Splice Connections *3-45*
3.62.05 Exothermic Welds *3-45*
3.62.06 Exothermic Weld Coating *3-45*
3.62.07 Test Stations *3-45*
3.62.08 Insulating Flange Kits *3-46*
3.63.00 METERS 3-46
3.63.01 General *3-46*
3.63.02 Magnetic Drive Positive Displacement-Type Water Meters *3-47*
3.63.03 Compound and Turbine Meters *3-47*
3.63.04 Mastered Meters *3-47*
3.63.05 Meter Bypass Line *3-47*
3.63.06 Meter Check Valves *3-47*
3.63.07 Meter Valves *3-48*
3.63.08 Meter Yokes (Setters) *3-48*
3.63.09 Valve and Meter Supports *3-49*
3.63.10 Meter Pits (3/4" and 1" service lines) *3-49*
3.64.00 PRESSURE-REDUCING VALVE 3-50
3.65.00 COMBINATION AIR VALVES 3-50
3.66.00 RESTRAINING SYSTEMS 3-50
3.66.01 Harness Rods *3-50*
3.66.02 Joint Restraint Devices *3-50*
3.67.00 CONCRETE REINFORCEMENT 3-51
3.68.00 BACKFLOW PREVENTION ASSEMBLIES 3-51
3.69.00 REPAIR CLAMPS 3-51

CHAPTER 3
WATER SYSTEM

3.00.00 INTRODUCTION

All water distribution systems constructed within the CITY of Westminster shall comply with the requirements of these STANDARDS AND SPECIFICATIONS and may include additional special criteria established by the CITY for overall hydraulics of the water utility system. Special criteria shall be outlined at pre-design meetings, as determined necessary by the CITY ENGINEER.

The DEVELOPER shall analyze any impacts to the existing off-site infrastructure. If there are any impacts, as determined by the CITY, additional analysis, such as hydraulic modeling, will be required at the DEVELOPER'S expense. If off-site PUBLIC IMPROVEMENTS are required for the proposed development to be successful, the CITY and the DEVELOPER will negotiate the scope of the improvements, any phasing, and payment by the developer to the CITY for these off-site PUBLIC IMPROVEMENTS.

All references to standards and manuals shall refer to the most current edition unless noted otherwise.

3.01.00 INTERRUPTION OF SERVICE

No valve or other control device on the existing public system will be operated for any purpose by anyone other than the Department of PWU (PWU).

The CITY PWU's Utilities Division shall operate all existing valves, hydrants, blow-offs and curb stops. Twenty-four hours prior to the interruption of service, the CONTRACTOR shall notify all users whose service will be interrupted in order for them to make provisions for necessary water storage. For water mains servicing commercial areas (e.g., restaurants) 48 hours prior notice shall be given, and work affecting the shut-down shall be coordinated with each business. No water line in service will be shut-down for more than a four-hour period at one time. Prior approval by the CITY ENGINEER is required for all shutdowns.

In certain situations, to lessen the impacts to adjacent customers (e.g. residences, businesses, schools, etc.), the WORK detailed in this section may require night or weekend construction at the direction of the CITY ENGINEER.

3.02.00 WATER BREAKS

If notification prior to shutdown is impossible, the CONTRACTOR shall notify all users within one (1) hour after the shutdown. Since prior notification was not possible, it will be the responsibility of the CONTRACTOR to supply potable water to the users affected. The CONTRACTOR shall also contact the PWU Utilities Division and the CITY's Fire Department in reference to this emergency shutdown within one (1) hour.

3.03.00 METER SET INSTALLATION REINSPECTION FEE

Water tap fees provide for the initial inspection of the meter set only. Where additional inspections are made necessary by incomplete or faulty work, a fee in accordance with CITY CODE will be charged for the second inspection and each subsequent inspection. This fee shall be charged to the holder of the permit and paid to the CITY before any additional inspections will be made.

TO SCHEDULE AN INSPECTION DURING REGULAR BUSINESS HOURS, CONTACT THE UTILITY OPERATIONS DIVISION METER SHOP AT 303-658-2549. FOR AFTER HOURS EMERGENCIES CALL POLICE DISPATCH AT 303-658-4360.

3.10.00 DESIGN CRITERIA

3.11.00 SCOPE

It is the intent of this section to provide sufficient detailed information to enable the DEVELOPER to correctly and efficiently design the overall water system for a particular development. If there is a question or a concern regarding the design of any portion of the water system that is not adequately answered within this chapter, the DEVELOPER shall contact the CITY to get all issues resolved prior to design. Any deviation from these STANDARDS AND SPECIFICATIONS must be approved in writing by the CITY ENGINEER.

3.12.00 GENERAL

The water system shall be designed by or under the direct supervision of a Professional Engineer registered in the State of Colorado utilizing the most current technical standards along with good, sound engineering judgment throughout the design process. The DEVELOPER shall have experience in the design and construction of municipal water distribution systems. The development approval process includes the submittal of a Preliminary Development Plan, an Official Development Plan, utility study and construction drawings for review and approval by the CITY ENGINEER.

For design of the water system, the CITY's Fire Department shall be contacted early in the design process in order to determine the required fire flows for proposed facilities. Fire flow requirements will likely dictate the sizing and layout of the water distribution system.

3.12.01 Water System Utility Study Requirements

The Utility Study shall include the following information and shall be bound in an 8 ½ x 11 inch folder:

B) **Certification statement** - shall be included at the beginning of the report and shall read as follows: "This Utility Report for the design of the _____development was prepared by me or under my direct supervision in accordance with the CITY of Westminster's Standards and Specifications and acceptable professional practices of the industry. We acknowledge that the CITY of Westminster's review of this

Utility Study is only for general conformance with submittal requirements, current design criteria and standard engineering principles and practices. We are also aware of the provisions of Section 11-6-5(B) of the CITY Code of the CITY of Westminster." The seal and signature of the Professional Engineer responsible for preparing the report shall follow this statement.

C) **Report text** for the water system design shall include the following at a minimum:

a) **Project location and Description** – a description of the boundary streets, project area and type of development proposed or anticipated use. Include a vicinity map.

b) **System layout** – a description of the existing and proposed water infrastructure in conformance with the CITY's latest master plan shall be provided and reference shall be made to a figure in the back of the report illustrating these improvements. The description shall include the sizes and types of existing and proposed pipes and the influence of the improvements on the project and surrounding area.

c) **Design flow requirements** – Complete design flow calculations and a discussion explaining the calculations and assumptions shall be provided. Items shall include types of facilities to be served, fire flow calculations based on building construction type and floor area, developed land area, number of units based on land use, and population densities. Calculations for Average Day, Max Day and Peak Hour demands shall be presented. Max Day plus Fire Flow and Peak Hour demand scenarios shall be evaluated for worst case and shall include domestic demands, building sprinkler flows and domestic irrigation flows. Data shall be presented in table format, if possible, for ease of reading. The report shall acknowledge that the Fire Department has provided the required fire flows and that they approve of the proposed fire hydrant locations.

d) **Off-site system requirements** – The report shall include a discussion of all PUBLIC IMPROVEMENTS needed to any off-site infrastructure, as determined by the CITY ENGINEER, to make the on-site infrastructure comply with CITY criteria including an analysis of water availability. If these PUBLIC IMPROVEMENTS to off-site infrastructure are anticipated then the off-site utility shall be included in the hydraulic modeling described in item e) that follows, at the DEVELOPER's expense. In addition to this analysis a cost estimate for these PUBLIC IMPROVEMENTS, as approved by the CITY ENGINEER, shall be included in the appendix of this report. For these PUBLIC IMPROVEMENTS, the CITY will inform the DEVELOPER if they will be allowed to construct these PUBLIC IMPROVEMENTS or if the CITY will construct these PUBLIC IMPROVEMENTS in accordance with item 3.00.00.

e) **Hydraulic Analysis** – A detailed description of modeling assumptions and rationale shall be provided in the report text such that the analysis is clear and can be confirmed. Results of the analysis at a minimum shall include: minimum and maximum system pressures for the various scenarios modeled,

corresponding node locations, distribution of fire flows among hydrants, and maximum pipe velocities. Data should be presented in table format. Reference shall be made to modeling data in the appendix and a figure of the pipe and node network provided.

f) **Conclusions** – a description of the results and how they follow the CITY criteria shall be provided. Any deviations from the CITY criteria shall be described and applicable variances requested.

g) **Appendices** - Printed data output from the modeling results shall be provided in the appendix and shall correspond with a figure of the pipe and node network. The appendix shall also include hydrant flow test results, hand calculations and any other pertinent data. A large size figure (24" x 36") illustrating the existing and proposed utility improvements shall be provided and shall conform to the CITY's latest master plan. The drawing shall include pressure zone boundaries, building finished floor elevations, elevation contours and locations of proposed and existing utility easements and right-of-way.

In situations where a previous utility study was conducted and is still applicable, a utility conformance letter may be submitted in place of the Utility Study, at the discretion and with written authorization of the CITY ENGINEER.

3.13.0 DESIGN DEMAND

The domestic demands for a particular development vary depending on the type of development, land use density, irrigation demand and building fire sprinkler flow requirements. However, the demand used to design a water system is largely a function of the required fire flow for a particular development.

There are two general categories of development for which domestic flow rates are determined: residential and commercial/industrial. Domestic demands for these developments are determined from Tables 3.13.A, 3.13.B and 3.13.C below and then peaking factors are applied to develop the Maximum Day Demand and Peak Hour Demand as follows:

Maximum Day Demand = 2.5 x Average Day Demand
Peak Hour Demand = 4.0 x Average Day Demand

Domestic demands for a development shall be combined with peak irrigation demand, building fire sprinkler demand and the project fire flow. The peak irrigation demand shall be determined by the irrigation designer and the fire sprinkler demand shall be determined by the fire sprinkler Engineer. The fire flow for a project is determined from the International Fire Code (Edition currently approved by the CITY Building Department) and requires the approval of the CITY Fire Marshal. Factors such as building area and construction type are required to determine the fire flow for a structure.

The design of the water distribution system shall be based on the higher of the two demand scenarios:

Maximum Day Demand + project fire flow + building fire sprinkler flow + peak irrigation flow, or

Peak Hour Demand + peak irrigation flow.

The CITY shall be consulted for design criteria with regard to non-standard developments, design of municipal infrastructure such as transmission mains, pump stations, etc. and for developments with unusually high demands. The CITY ENGINEER shall have final input in these instances.

Residential Average Day Demand shall be based on density, and zoning as determined by the Preliminary Development Plan and Official Development Plan for the project and the proposed number of units. This estimate is to be used solely for the purposes of planning and design infrastructure. The CITY PWU's Water Resources Division shall be contacted to determine tap size and fees.

Table 3.13.A – Residential Average Day Demand Data.

Zoning	Type of Development	Units per Acre	People per Unit	Gallons per person per day
R-1 to R-5	Single Family Detached	Up to 5	2.90	89
R-8 to R-18 and District Center	Single Family Attached	Up to 18	2.00	90
R-36	Attached, Multi-family	Up to 36	1.80	72

Commercial and industrial Average Day Demands will vary widely depending on the type of development. The following criteria in Table 3.13.B is based on historic information from the CITY's water records and can be used to estimate the water usage for the various developments listed for the purposes of infrastructure design. The CITY PWU's Water Resources Division shall be contacted to determine tap size and fees.

Table 3.13.B – Commercial/Industrial Average Day Demand Data

Type of Development	Unit	Indoor Design Demand (gallons/unit-day)
Auto Service and Repair	sf	0.12
Car Wash	bay	528
Childcare	sf	0.32
Church	sf	0.18
Grocery Store	sf	0.22
Gas Station with Car Wash	sf	8
Gas Station without Car Wash	sf	1.32

Hospital	sf	0.32
Hotel/Motel	room	130
Medical Office	sf	0.2
General Offices	sf	0.04
Restaurant	sf	1.1
Retail/Shopping Center	sf	0.16
School	sf	0.06
Warehouse/Industrial	sf	0.04

For commercial and industrial planning purpose, where specific densities and building uses are not yet known, average day demands can be calculated on an acreage basis as specified in Table 3.13.C.

Table 3.13.C – Commercial/Industrial Average Day Demand Data (Based on Acreage)

Type of Development	Gallons per Acre-Day
Retail Commercial	1430
Office	1430
Office – High density	2480
Mixed-Use	4100
Industrial	1430
School/Church	1260

If the developer has specific information for their proposal that is different from the above, and the developer wishes to design using the different information, the developer must contact PWU to discuss and obtain approval.

3.14.00 HYDRAULIC DESIGN

A computer-generated hydraulic analysis of the proposed infrastructure, or "model", shall be developed using standard industry software such as WaterCAD or CITY approved equal. In order for the model to properly correlate with the CITY's distribution system, a hydrant flow test needs to be performed on nearby hydrants and static and residual pressures obtained as a function of flow rate. This data shall be used in the model to develop a water source curve, represented by a reservoir and pump, and this will allow modeled pressures to vary over a range of imposed demands. The water source curve functions as a boundary condition in the model where proposed piping interfaces with the existing distribution system at this boundary.

For purposes of hydraulic modeling, Hagen Williams C coefficient shall be 130 for PVC pipe, lined ductile iron pipe, and lined steel pipe. For any other condition, coordination with the PWU is required.

The objective during hydrant flow testing is to obtain a flow rate similar to the design demand required for the proposed development. The hydrants to be tested shall be determined by the PWU and data obtained during this test shall be valid for up to one-year, unless otherwise approved in writing by the PWU. Distribution system factors may require that a fire flow be increased for a particular area of the

system, as determined by PWU. A hydrant flow test shall be requested by the DEVELOPER from the CITY's Fire Department.

Special analysis may be required by the CITY ENGINEER for developments requiring large flow demands and shall be discussed with the Utilities Division. Future changes in zone pressures, in conformance with the CITY's latest master plan, shall be considered in the hydraulic analysis.

Upon approval by the CITY ENGINEER, the requirement for a computer-generated hydraulic analysis may be waived for the following:

- Developments requiring low domestic demands (less than 600 gpm) and with no fire flow requirement; or
- Developments proposing less than 200 feet of water main and no required fire hydrants.

For the above cases, hydraulic calculations should be provided as part of the Utility Study and shall demonstrate acceptable system pressures and velocities as a result of required flows.

3.15.00 OPERATING PRESSURES WITHIN THE DISTRIBUTION SYSTEM

Minimum recommended pressure within the distribution system shall be 50 pounds per square inch during the Peak Hour Demand and the maximum recommended pressure during the Average Day Demand shall be 100 pounds per square inch.

The maximum pressure fluctuation at any location in the distribution system between Peak Hour Demand and Average Day Demand shall not exceed 30 pounds per square inch.

The minimum pressure at the ground surface (i.e., hydrant nozzle) shall be 20 pounds per square inch under all scenarios, including fire flow. The Utility Study shall discuss the pressure at the highest occupied space in all buildings and provide a recommendation on the need for a domestic booster pump and/or the need for a fire pump to supply fire sprinkler systems.

3.16.00 PRESSURE REGULATING STATIONS

Pressure reducing valve (PRV) installations should be avoided. In areas where a main extension may cause pressures to be greater than the existing zone pressure, the DEVELOPER must discuss alternatives with PWU. Detailed design of any PRV installations shall be performed by the DEVELOPER with input from PWU.

For individual water services to buildings, water pressure regulators will be required if system pressures exceed 80 psi or at the discretion of the CITY's Building Division.

3.17.00 SIZING OF MAINS

3.17.01 Distribution Mains

All water mains shall be sized large enough to provide for domestic, irrigation, and fire protection flows to the area serviced. The maximum acceptable head loss for six, eight, ten and twelve inch mains is two feet per thousand feet of main for the Peak Hour Demand scenario. This acceptable head loss rate shall not apply for fire flow scenarios. The maximum pipe velocity for non-fire flow scenarios shall be 5 feet per second and for fire flow scenarios shall be 7 feet per second. Final size of distribution mains shall be approved in writing by the CITY ENGINEER. Over sizing of mains may be required by the CITY ENGINEER, and the recovery of the costs of such over sizing shall be in accordance with Section 11-6-7 of CITY CODE.

The minimum diameter for water mains that have fire hydrants is 8 inches. All waterlines shall be looped. Mains in residential areas that do not have fire hydrants may be 6 inches, with written approval of the CITY ENGINEER. No dead-end mains, except lines extending into cul-de-sacs serving not less than 3 and not more than 6 single-family residential units, nor mains extending more than 150 feet from the lateral connection, will be permitted. All stubs and dead end mains shall have a blow-off installed. With the exception of fire hydrant laterals, only polyvinyl chloride (PVC) pipe is approved for water main installations 12 inches in diameter and smaller. Any other material proposed must be approved in writing by the CITY ENGINEER prior to construction. A Hazen-Williams “C” coefficient of 130 shall be used when modeling PVC and DIP pipe.

3.17.02 Transmission Mains

All transmission mains shall be sized in compliance with the CITY's "Water Distribution System Study," latest edition, or as otherwise approved in writing by the CITY ENGINEER. See section 3.22.00 for further details.

3.18.00 SYSTEM LAYOUT – CONSTRUCTION PLAN CRITERIA

3.18.01 General

All water mains shall be installed in dedicated RIGHT-OF-WAY or utility easement dedicated to the CITY. Water main installation in easements between single-family residential lots will only be allowed for the purpose of looping a water main at the end of a cul-de-sac. Waterlines should NOT be installed parallel to and directly below any concrete such as sidewalks, curbs, or gutters. Lines shall normally be located 5 feet north or west of street centerline, or 5 feet north or west of a curbed median, unless otherwise approved in writing by the CITY ENGINEER.

The minimum depth of cover for water mains from the final approved grade of the surface to the top of the water main shall be 5 feet. Where final grades have not been established, mains shall be installed to a depth great enough to insure 5 feet of cover below the approved future grade but in no event less

than 5 feet of cover from the temporary grade. The maximum depth of cover for water mains shall be 8 feet below the final approved grade of the surface unless approved otherwise, in writing, by the CITY ENGINEER.

Plan and profile shall be required for all water main designs. Utility crossings shall be identified in the profile views for all known or planned utilities. The vertical alignment of water mains shall be designed such that unnecessary high points are avoided. If a high point in the main cannot be avoided, a controlled high point shall be located at a fire hydrant tee where trapped air in the system can be bled. High points at a water main lowering should be avoided by deflecting the main on both sides of the lowering such that positive pipe grades are maintained to controlled high points in the system. To maintain positive pipe grades to controlled high points, the maximum depth of cover to the main can increase to 8 feet, if approved in writing by the CITY ENGINEER. Refer to Sections 3.18.02 through 3.18.06 for the alignment of water lines with sewer lines. Refer to Section 3.18.07 for the design of combination air valves.

Water mains shall be laid a minimum of ten feet, horizontally and edge to edge, from any existing or proposed utility. Upon written approval by the CITY ENGINEER, a water main may be laid closer than ten feet to a parallel sewer main if it is laid in a separate trench and if the elevation of the invert of the water main is at least 18 inches above the crown of the sewer main and, in addition, PVC C-900 is used for the sewer main.

Water mains shall be designed such that they extend the entire frontage of the property to be served or as otherwise approved in writing by the CITY ENGINEER.

When the water main passes under a highway, railroad, or waterway, there shall be a minimum of five feet of cover and a steel casing shall be installed in accordance with the standard drawing in the Appendix of this chapter. The steel casing shall extend the entire width of the RIGHT-OF-WAY or easement of the crossing structure or as directed by the CITY ENGINEER. In all cases, valves shall be located such that the water main at such crossings can be completely isolated without interruption of any services.

3.18.02 Waterline Crossing Over a Sanitary Sewer Line

When there is less than 18 inches of vertical clearance between the water main and the sanitary sewer pipe, or water main pipe joints extend less than 10 feet each side of the sewer pipe, one of the following secondary containments shall be required for the water or sewer pipe:

1. Utilize Pressure Pipe AWWA C900.
2. Concrete or flowable fill encasement, extending to any joints within 10 feet of the crossing.

Note that if joint-less pipe, such as fusible PVC or welded steel, is used for the water or sanitary sewer pipe then secondary containment will not be required. However, structural support of the water or sewer main using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

Minimum criteria is presented in this section, and applies to both public mains and private service lines.

3.18.03 Waterline Crossing Over a Storm Sewer Line

When there is less than 18 inches of vertical clearance between the water main and the storm sewer, the water line shall be cased. Alternately, with written approval by the CITY ENGINEER, each joint of the storm sewer within nine feet of the centerline of the crossing shall be encased in concrete.

Freeze potential of a water main shall be evaluated when crossing storm sewers or other exposures to the elements. If a water main crosses a storm sewer with 3 feet or less of vertical clearance, a 12" thick layer of extruded polystyrene insulating foam, also referred to as "XPS" shall be provided all around the water main for a minimum of 5 feet on each side of the storm sewer. The sheets of "XPS" shall be thick enough to allow shaping of the material so it fits snugly around all sides of the pipe leaving a minimum 12" thickness around all sides of the pipe. Bonding of individual sheets of "XPS" shall be in accordance with section 3.61.03 of these Standards and Specifications. Crossings of dead end water mains and storm sewer with less than 18 inches of vertical clearance shall be prohibited.

3.18.04 Sanitary Sewer Line Crossing Over a Waterline

When there is less than 18 inches of vertical clearance between the water main and the sanitary sewer pipe, or water main pipe joints extend less than 1. feet each side of the sewer pipe, one of the following secondary containments shall be required for the water or sewer pipe:

1. Utilize Pressure Pipe AWWA C900.
2. Concrete or flowable fill encasement, extending to any joints within 10 feet of the crossing.

Note that if joint-less pipe, such as fusible PVC or welded steel, is used for the water or sanitary sewer pipe then secondary containment will not be required. However, structural support of the water or sewer main using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

Minimum criteria is presented in this section, and applies to both public mains and private service lines.

3.18.05 Storm Sewer Line Crossing Over A Waterline

In all cases, regardless of vertical clearance, the water line shall be cased. Alternately, with written approval by the CITY ENGINEER, the joints of the storm sewer shall be encased in concrete a minimum of nine feet on each side of the centerline of the crossing.

Freeze potential of a water main shall be evaluated when crossing storm sewers or other exposures to the elements. If a water main crosses a storm sewer with 3 feet or less of vertical clearance, a 12" thick layer of extruded polystyrene insulating foam, also referred to as "XPS" shall be provided all around the water main for a minimum of 5 feet on each side of the storm sewer. The sheets of "XPS" shall be thick enough to allow shaping of the material so it fits snugly around all sides of the pipe leaving a minimum 12" thickness around all sides of the pipe. Bonding of individual sheets of "XPS" shall be in accordance with section 3.61.03 of these Standards and Specifications. Crossings of dead end water mains and storm sewer with less than 18 inches of vertical clearance shall be prohibited.

3.18.06 Limits on Vertical Separation

Under no circumstances shall the vertical clearance between any waterline and sanitary sewer or storm sewer be less than 18 inches without written approval from the CITY ENGINEER.

3.18.07 Combination Air Valves

Combination air valves are necessary to serve several functions: they exhaust large volumes of air from the system during start-up, they open during draining or if a negative pressure occurs and they release accumulated air from the system during operation. The vertical alignment of water mains shall be designed such that unnecessary high points are avoided as described in section 3.18.01 of these STANDARDS AND SPECIFICATIONS. If a high point in a distribution water main cannot be avoided, a controlled high point shall desirably be located at a fire hydrant tee where trapped air in the system can be bled through the fire hydrant. If this is not possible due to legitimate design constraints, an air valve shall be located at the high point and within a manhole.

Combination air valves for distribution mains and transmission mains shall be sized by the design engineer in accordance with the manufacturer's recommendations and approved by the CITY ENGINEER.

3.19.00 EASEMENTS

All water mains shall be in an easement which has a horizontal width of at least two times the depth to the pipe invert. The minimum easement shall be 20 feet in width for one utility, 30 feet in width for two utilities, and 40 feet in width for three utilities. Site-specific circumstances may dictate the need for wider easements. For normal depths, the main shall be located a minimum of 10 feet from and parallel to the edge of the easement. Meters and fire hydrants not installed within the

right-of-way will require an easement dedication ten feet wide and extending five feet behind the meter or fire hydrant. If a fire hydrant lateral or water meter extends behind the curb more than ten feet, then the width of the easement shall be a minimum of 15 feet. All easements shall be for the exclusive use of the CITY. Neither landscaping (except grass and private irrigation systems) nor permanent structures (sheds, buildings, etc.) shall be placed in the easement.

The easement agreement, provided by the CITY, shall state that any temporary structures (including paving and fencing) placed in the easement shall be removed and replaced by the owner of the land when requested by the CITY so that maintenance can be performed. The OWNER shall agree to hold the CITY harmless for any replacement of structures removed from the easement.

The following statement shall appear on all Official Development Plans and all Final Plats**.**

UTILITY MAINTENANCE STATEMENT

All public water, storm sewer and sanitary sewer mains and appurtenances located in public right-of-way shall be maintained by the CITY of Westminster Public Works Department. All public water, storm sewer, sanitary sewer mains and appurtenances under private drives are located in utility easements. CITY is responsible for maintenance of these water, storm and sanitary sewer facilities. CITY is not responsible for repair or replacement of private drive, curb and gutter or landscaping damaged during utility repair or maintenance.

3.20.00 FUTURE CONNECTIONS

A blow-off is required at the end of any water main which terminates and is anticipated to be extended in the future. Refer to the detail drawing in the Appendix of this chapter. When a future main extension is anticipated, the main shall include valves so that only one valve will have to be closed when the main is extended. The valve shall be restrained so when the one valve is closed and the line to be extended is exposed, the valve will not blow off. Restraint shall be made by the use of a mechanical joint anchoring tee (swivel tee), swivel cross, and by installing a minimum of two full lengths of pipe on the extension side of the valve (8 inch pipe and smaller). No service taps shall be allowed on a main which can be extended in the future between the single valve to be closed and the dead end.

3.21.00 SERVICES

Calculations for meter and service line sizes shall be prepared using the “Plumbing Data Sheet” available from Public Works. The applicant shall prepare building plans and calculations and submit them to the Building Division for review and approval. The CITY’s Building Division must approve all meter and service line sizes (before and after the meter) prior to beginning construction. The service lines, tap and meter shall be the same size, unless otherwise approved and/or required by the CITY ENGINEER. If the tap and meter are of different sizes, the fee shall be paid based on the larger size, unless a larger tap is approved and/or required by the CITY ENGINEER in which case the fee for the meter size shall be paid.

Each separated structure shall be served by a separate service line and meter. All non-residential developments with any irrigated areas are required to have separate irrigation taps and meters from the water main in accordance with Section 8-7-3(D) of CITY CODE. Utility easements shall be required for service lines up to and including the meter pit.

No pressure booster facility of any kind shall be allowed on any service line between the public main and the meter. All service line pressure booster facilities shall be privately owned and maintained.

Water service lines shall be located a minimum of 10 feet away from all sewer services and a minimum of 5 feet away from all fire protection service lines (measured horizontally). All service lines shall be constructed perpendicular to the front property line of the property they are going to serve and not less than 5 feet from the side of a front property line. Service lines through private property to serve a separate property are prohibited.

Size changes, if allowed between the service line and the meter, shall be accomplished by providing a full-sized meter vault and setter for the line size installed and using industry standard adapters to install a reduced size meter in the full size line.

Water taps cannot be issued prior to a building and/or tap entitlement approval. Exceptions must be approved by the CITY MANAGER; for example, conversion from well water to the CITY water system.

All service lines 3/4-inch through 2-inch shall be copper and shall be installed continuous without joints between the corporation stop at the water main and the meter or curb stop. ¾" to 1" Services shall be tapped at the main with a 45 degree angle from horizontal and all taps 3/4"-2" shall have a minimum of 5 feet of cover and be laid as shown on the detail drawing in the Appendix of this chapter. The minor exception to this is allowed for the "slack" section in the service line near the tap which may have slightly less than 5 feet of cover.

Service connections requiring a flow greater than can be delivered through a 2-inch corporation and service line shall be 4-inch, 6-inch, or 8-inch connections and shall be polyvinyl chloride pipe in accordance with section 3.52.02 of these STANDARDS AND SPECIFICATIONS. Service connections (4-inch, 6-inch, or 8-inch) to new lines shall be made with mechanical joint anchoring tees (swivel tees) or reducing mechanical joint anchoring tees (swivel tees) if installed at the time of main line construction. Later connections, if installed, may also be made with tapping sleeves and tapping valves and at the developer's expense.

3.22.00 TRANSMISSION MAINS

All water mains larger than 12 inch in diameter shall be classified as "transmission mains."

All transmission mains shall have combination air valves installed at all high points on the line and on each side of butterfly valves in accordance with the detail drawing in the Appendix of this chapter.

All transmission mains shall have blow-off assemblies installed at all low points on the line and constructed in accordance with the detail drawing in the Appendix of this chapter.

The design of ductile iron and steel transmission mains and other critical direct bury appurtenances such as valves, shall require cathodic protection. Cathodic protection shall be designed by a qualified cathodic protection engineer, registered in the State of Colorado and shall conform to NACE Standard RP-01-69, latest revision. As a minimum, the cathodic protection system shall include magnesium anodes; test station thermal board and shunts; exothermic weld caps and coating; conductor, test stations, joint bond wires; wire splice kits; exothermic weld equipment and materials; wire and cable marker tags; and one-piece insulating sleeves and washers, all in conformance with section 3.62.00 of these STANDARDS AND SPECIFICATIONS. All of the data for these materials shall be submitted to the CITY for approval prior to installation. Test stations shall be shown on design drawings and as-built drawings. Cathodically protected pipe, except steel casing pipe, shall also require polyethylene wrap as described in section 3.61.02.

No service line taps or any taps less than six inches in diameter shall be made to transmission mains. Exceptions to this will be for combination air valves only.

Valves on transmission mains shall be placed no more than 1,200 feet apart. Where there are connections to transmission mains, all connecting mains shall include valves at the connection. There shall be a minimum of two valves at a tee connection and three valves at a cross connection.

3.23.0 UNLAWFUL CONNECTION

No installation of potable water supply piping or part thereof shall be made in such a manner that it will be possible for used, unclean, polluted, or contaminated water, mixtures, or substances to enter any portion of such piping from any tank, receptacle, equipment, or plumbing fixture by reason of back siphonage, suction, back pressure, or any other cause, either during normal use and operation or when any such tank receptacle, equipment, or plumbing fixture is flooded, or subject to pressure in excess of the main line operating pressure. No person shall make a connection or allow one to exist between pipes or conduits carrying domestic water supplied by the CITY and any pipes, conduits, or fixtures containing or carrying water, chemicals, liquids, gases, or any other substances from any other source. Refer to Section 3.24.08, Backflow Prevention Assemblies for further requirements.

3.24.00 APPURTENANCES

3.24.01 Valves

Residential distribution systems shall include valves to ensure that no more than 600 feet of main or 18 residential units and 1 fire hydrant will be out of service in the event of a single water main break. Valve placement shall be

such that there are at least two valves at every tee and three valves at every cross.

Valves 16 inch or larger shall be butterfly valves. Main line valves shall be located at a tee, cross or elbow if possible. Under no circumstances shall a valve be located in concrete areas, such as sidewalks, crosspans, aprons, curbs, or gutters. Butterfly valve operators shall be located on the north or east side of the water main. Any valve located in a greenbelt area shall have an 18-inch-wide by 6-inch thick concrete collar around the valve box. All 16" and larger butterfly valves will be accessible in a vault.

3.24.02 Fire Hydrants

The maximum distance, as measured along the centerline of the street, between fire hydrants shall be 500 feet in residential areas and 300 feet in business and other high-value areas unless otherwise approved in writing by the CITY ENGINEER. One fire hydrant will be allowed on dead-end line provided that the line is an 8" line. The number and location of fire hydrants in a given area shall be approved in writing by the Fire Department. If hydrants are to be installed at locations other than street intersections, they shall be located on the extension of property side lot lines. In no case shall a hydrant be located closer than 5 feet to obstructions, driveways, etc. The fire hydrant shall be located within the right-of-way or pocket Utility Easement and on the same side of the street as the water main unless otherwise approved in writing by the CITY ENGINEER. Fences, landscaping, etc., shall in no way hinder the operation of the fire hydrant. In addition, clear distances to the fire hydrant shall be in accordance with Section 3.19.00 of these STANDARDS AND SPECIFICATIONS.

The fire hydrant lateral lines shall be set at 90 degrees to mains. The length of the fire hydrant lateral line shall be minimized and shall be no more than 50 feet long unless approved by CITY ENGINEER. No horizontal bends or offsets shall be used in fire hydrant lateral lines. Under no circumstances shall any tap be made on a fire hydrant lateral line.

3.24.03 Thrust Blocks and Joint Restraint Devices

All bends, tees, plugs, dead-ends, wet taps (in certain cases), hydrants, and blow-offs shall be designed and constructed with concrete thrust blocks. If the soil-bearing strength is unknown, the soil-bearing capacity used in design shall be 2,000 pounds/square foot. Refer to the detail drawings in the Appendix of this chapter.

Joint restraint devices shall be used on both sides of valves and fittings for pipe sizes 12 inches in diameter and smaller and in addition to thrust blocks. Vertical bends in all pipe sizes shall be restrained using joint restraint devices and shall be restrained for a specified distance as recommended using the latest edition of AWWA Manual M23 and M41, as appropriate.

Harness rods, or "rodding", are not an acceptable means for restraining pipe and fittings unless it is specified inside vaults as shown on the detail drawings

in the Appendix of this chapter. Under no circumstance shall steel harness rods be allowed to be in contact with soils.

3.24.04 Meters

Calculations for meter and service line sizes (before and after the meter) shall be prepared using the "Plumbing Data Sheet" available from PWU. The applicant shall prepare building plans for review and approval by the Building Division. Concurrently, water demand calculations shall conform to the building plans and shall be submitted to PWU to determine meter size, water tap fees, and sewer tap fees. The service lines, tap and meter shall be the same size, unless otherwise approved and/or required by the CITY ENGINEER. If the tap and meter are of different sizes, the fee shall be paid for the larger, unless a larger tap is approved and/or required by the CITY ENGINEER in which case the fee for the meter size shall be paid.

Water taps cannot be issued prior to a building and/or tap entitlement approval. Exceptions must be approved by the CITY MANAGER; for example, conversion from well water to the CITY water system.

Public water meter installations inside any buildings are prohibited in all areas of the service area except Downtown Westminster and near Westminster Station unless otherwise approved, in writing, by the CITY ENGINEER. The urban areas of downtown and Westminster Station shall have indoor meters, unless otherwise approved, in writing, by the CITY ENGINEER. Meters shall be located within publicly owned rights-of-way or easements. Meter pits shall not be located within concrete areas or areas exposed to vehicle traffic, unless otherwise approved in writing by the CITY ENGINEER. If the CITY ENGINEER approves of locating a meter pit in a concrete area or an area exposed to light vehicle traffic, then a heavy-duty meter pit design shall be used in accordance with the design detail in the Appendix of this chapter.

All water meters connected to the CITY's utility system shall be the property of the CITY. Under no circumstances shall anyone other than CITY PWU personnel remove a water meter once the pit or vault has been inspected and approved. No connections shall be made in the meter pit, for irrigation or otherwise, by anyone other than authorized CITY PWU personnel. Irrigation system connections shall be made downstream from the meter and a minimum of five feet from the meter pit or vault.

For any installation where special or unusual conditions might exist, detailed drawings, accompanied by a letter of explanation, shall be submitted to the CITY ENGINEER for review and approval.

For any water meter installation over 2 inches in size, detailed drawings of the proposed installation shall be submitted to the CITY ENGINEER for review and approval prior to construction.

There shall be no electrical wiring allowed in any water meter pit or vault unless authorized, in writing, by the CITY ENGINEER.

Inspections of all residential pits and commercial pits or vaults shall be conducted by the CITY. Locations and details for commercial pits or vaults shall be reviewed and approved in writing by the CITY ENGINEER.

3.24.05 Fire Protection Service Line

All Buildings except single-family residential: Valves on newly constructed fire lines shall be located on the tee at the main line. The owner shall maintain all private fire lines beginning at and including this valve. All fire sprinkler taps shall be installed with an approved backflow prevention device as defined in Section 8-7-27 of CITY CODE, and a flow switch which will indicate when water has flowed through the line. A property requiring a domestic service line and a fire protection service line will have separate taps for each. Fire protection service lines shall be constructed of PVC from the fire line valve to the 90 degree bend for the building standpipe. The 90 degree bend and standpipe shall be ductile iron pipe in conformance with the International Fire Code as adopted by the Building Division. Fire line valves shall have a flange connection and shall bolt directly to a mechanical joint anchoring tee (swivel tee) at the main.

Single family residential (including townhome): Fire protection systems are required for all residential spaces. Fire protection systems that are not passive purge are required to have a backflow preventer installed in the meter pit. A 1" meter is required, at no additional cost.

3.24.06 Valve Vaults

All valves larger than 12 inches shall be installed in a vault in accordance with the detail drawings in the Appendix of this chapter. All valve vaults shall be capable of withstanding AASHTO H-20 highway loading. The vault shall also have lift hooks in the roof for valve removal inside the vault.

Vaults shall be made waterproof after construction by use of sealants, epoxies or other approved methods. All vaults shall be designed with wall sleeves and link seal and be capable of handling thrusts caused by removing valves. All vent pipes for vaults shall be installed in conformance with the detail drawings in the Appendix of this chapter.

3.24.07 Manholes

Manholes shall be installed on all pressure regulating valves, all butterfly valves, permanent blow-off installations, and air release valves in accordance with the detail drawing in the Appendix of this chapter.

3.24.08 Backflow Prevention Assemblies

To prevent backflow contamination of the CITY's potable water system, a reduced pressure zone (RPZ) backflow prevention device shall be installed inside the structure after the main shut off valve on all non-single-family residential water service lines or where any condition might exist that would result in a higher pressure downstream of the water meter than exists in the

main line and that could allow backflow or back siphonage of polluted or contaminated water or other substances from the water user's system. The assembly shall be installed per CDPHE guidelines and Section 8-7-27 of CITY CODE to allow for proper operation and easy access for annual testing and maintenance.

A reduced pressure zone backflow prevention device shall be used for all non-residential irrigation services. This shall be required for both domestic and reclaimed water sources. The assembly shall be located a minimum of five feet downstream of the water meter and installed per CDPHE guidelines and Section 8-7-27 of CITY CODE to allow for proper operation and easy access for annual testing and maintenance.

3.30.00 CONSTRUCTION SPECIFICATIONS

3.31.00 TRENCHING, BACKFILLING AND COMPACTION

Trenching, backfilling and compaction shall be done in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

3.32.00 BEDDING

In the event unstable trench conditions are found at pipeline grade, a minimum of one and one-half inch uniformly graded, washed rock shall be used for trench stabilization. Depth of the stabilization shall be as approved in writing by the CITY ENGINEER.

Granular bedding material shall meet the requirements of Chapter 9 of these STANDARDS AND SPECIFICATIONS. Bedding shall be placed to six inches below the bottom of the pipe and shall be placed around the sides of the pipe and to a minimum of 12 inches above the top of the pipe and in accordance with the detail drawing in the Appendix of this chapter.

3.33.00 PIPELINE INSTALLATION

3.33.01 General

The CITY shall be notified at least 48 hours in advance of any pipe installation. No pipes shall be backfilled until they have been inspected by the CITY INSPECTOR. Alignment and grade of the pipe and the location of fittings, valves, and hydrants shall be staked in accordance with the approved construction plans under the supervision of a Professional Land Surveyor registered in the State of Colorado.

Proper implements, tools, and facilities shall be provided and used by the CONTRACTOR for the safe and convenient execution of the work. All pipe fittings, valves, and hydrants shall be carefully lowered into the trench by means of a derrick, ropes, or other suitable tools or equipment to prevent damage to water main materials and protective coatings and linings. Chains or cables shall not be used for handling pipe with protective coatings. Under

no circumstances shall water main materials be dropped or dumped into the trench.

All pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. The groove in the bells of the pipe shall be full and continuous or the pipe will be rejected. Defective pipe or fittings shall be removed from the job site within 24 hours of notification by the CITY ENGINEER. All foreign matter or dirt shall be removed from the interior and ends of pipe and accessories before they are lowered into position in the trench and prior to connection.

Every precaution shall be taken to prevent foreign material and trench water from entering the pipe and fittings. During construction, the CONTRACTOR shall provide and maintain adequate equipment to properly remove and dispose of all water entering the trench and any other part of the work.

3.33.02 Pipe

Immediately before joining two lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned. Caution shall be exercised to ensure that the correct type of gasket is used. A thin film of gasket lubricant shall be applied to the inside face of the gasket and the spigot end of the pipe. The spigot end of the pipe shall be placed in the bell with care to prevent the joint from contacting the ground. The joint shall be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements. Pipe furnished without a depth mark shall be marked before assembly to ensure insertion to the Full depth of the joint. The pipe shall then be properly set and brought to correct line and grade. After installation of the polyethylene protective wrap, if required, the pipe shall be secured in place by installation of bedding material and backfill, in accordance with Chapter 9 and the detailed drawings in the Appendix of this chapter. All pipe laying shall be in accordance with AWWA C600 and AWWA C605.

Deflection from a straight line or grade, as required by horizontal or vertical alignments or offsets, shall not exceed fifty percent (50%) of the maximum allowable limits set by the manufacturer's specifications. If the alignment requires deflection in excess of the allowable deflection per joint, special bends, or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limits set forth, as approved, in writing, by the CITY ENGINEER.

All fittings, appurtenances, and ductile iron pipe shall be protected with minimum 8 mil polyethylene film wrap in accordance with Section 3.61.02 of these STANDARDS AND SPECIFICATIONS. Additionally, approved wax taping and zinc caps shall be placed on all bolted fittings. Miscellaneous steel or other ferrous pipe for temporary blow-offs, etc., shall be similarly protected. Methods for applying the wrap shall conform to the detail drawing in the Appendix of this chapter.

At times when installation is not in progress, the open ends of the pipe shall be closed with a watertight plug. Pipe should be kept clean, dry, and supported off the surface of the ground. 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 lining, leaving a smooth end at right angles to the axis of the pipe. Pipe ends shall be smooth and beveled with a file or other tools according to the pipe manufacturer's recommendations.

Extra care should be used in handling PVC pipe during cold weather due to the reduced flexibility and impact resistance as temperatures approach and drop below freezing. PVC pipe to be stored outside and exposed to sunlight for more than 30 days shall be covered with an opaque material such as canvas. Clear plastic sheets shall not be used to cover the pipe. Air circulation shall be provided under the covering. Any over-exposed pipe, as determined by the CITY ENGINEER, will not be permitted for installation.

All PVC waterline installations shall include the installation of a single, 12-gauge, insulated copper tracing wire taped to the top of the pipe. The tracing wire shall be installed in a continuous run between fire hydrants and the ends of the tracer wire shall be brought to the surface in a cathodic protection box next to the fire hydrant in accordance with the detail drawing in the Appendix of this chapter. Wire splices shall be accomplished in accordance with the detail in the appendix of this chapter. Tracer wire shall be tested by the CITY INSPECTOR, or by the CONTRACTOR and observed by the CITY INSPECTOR, for continuity prior to acceptance.

During the backfilling of all PVC waterline trenches, a continuous 2-inch-wide metallic-coated, detectable tape labeled "Waterline Buried Below" shall be placed in the trench backfill 2 feet above and directly over the pipe. Detectable tape shall be manufactured by Pro-Line, or CITY approved equal.

Following backfill and compaction of the water mains, cathodic protection test stations, shall be tested for effectiveness by the CONTRACTOR and the results of the continuity test shall be submitted to the CITY ENGINEER. If cathodic protection of the pipe is determined not to meet industry standards, then corrections shall be made until it meets industry standards and is accepted by the CITY ENGINEER.

3.33.03 Fittings

Pipes shall be connected to valves and fittings by mechanical joints unless specified differently in the approved drawings. For approved slip-on joints, the joint shall be assembled with a ratchet jack or other approved method in a manner that does not cause any damage to the pipe. Both the spigot and bell must be thoroughly clean and free from tar or other coatings and rust.

For mechanical joint pipe, the last 8 inches of the outside of the spigot end of the pipe and the inside of the bell of all 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 a thin film of gasket lubricant shall be applied. The cast iron gland shall then be slipped on the spigot end

of the pipe with the lip extension of the gland toward the bell of the fitting. Gasket lubricant shall be applied to the rubber gasket and placed on the spigot end of the pipe with the thick edge towards the gland.

After the spigot end of the pipe is placed into the bell and fully inserted the gasket shall be pressed into place within the bell so it is even 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 in accordance with manufacturer's recommendations. Nuts spaced 180 degrees apart shall be tightened alternately to produce equal pressure on all parts of the gland. All fittings must have approved zinc caps and wax tape.

Jointing shall be done in accordance with AWWA Specification C-111, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings, for all mechanical joint fittings.

3.34.00 VALVE AND VALVE BOX INSTALLATIONS

In addition to the jointing requirements mentioned in Section 3.33.03 of these STANDARDS AND SPECIFICATIONS, the additional requirements of this section shall apply. Valves and valve boxes shall be installed where shown on the approved drawings and as directed by the CITY ENGINEER. Valve boxes shall be firmly supported, centered, and plumbed over the operating nut of the valve with the box cover at or minus 1/4-inch within the surface of the finished pavement or at such other elevation as may be directed by the CITY ENGINEER. Extensions to within 4 feet of the finished grade shall be provided for valves installed with more than 5 feet of cover. All extensions shall be pinned to the valve operating nut. Earth fill shall be carefully tamped around each valve box to a minimum distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet. Valves shall have the interiors cleaned of all foreign matter before and after installation. For valve box installations in flow fill, pipe wrap must be used on the exterior of the valve box.

Gear cases shall be tightened and the valve shall be inspected in opened and closed positions to insure that all parts are in working condition prior to installation. The cases shall be supported by concrete blocks to prevent any shock or stress being transmitted to the valve.

3.35.00 THRUST BLOCKS

The CONTRACTOR shall excavate as required to ensure that the thrust blocks are placed against undisturbed soil and shall form the sides of the thrust block to provide the size and shape as required in the detail drawing in the Appendix of these Standards and Specifications. When it is impossible, because of over excavation or other causes, to pour a thrust block against undisturbed earth, harness rods shall be used to anchor the fittings to the main in addition to the thrust block and as required by the CITY ENGINEER. After the concrete has been placed and has set, the CONTRACTOR shall remove all forming materials prior to backfilling around the thrust block. Concrete for the thrust blocks shall comply with provisions set forth in Chapter 7 of these STANDARDS AND SPECIFICATIONS

The blocking shall be placed so that the pipe and fitting joints will be accessible for repair. A bond breaker shall be placed between the fittings and the thrust block. Backfill may be placed over the thrust blocks once the surface has set sufficiently to resist the weight of the backfill. However, no tamping or compacting shall be allowed above the thrust block for a minimum of 24 hours after placement. Concrete must set a minimum of 48 hours prior to the initial filling of the line.

3.36.00 CONNECTION TO EXISTING MAINS

At locations where connections to existing water mains are to be installed, the CONTRACTOR shall locate the existing mains, both vertically and horizontally, and shall verify their exact size in advance of the time scheduled for making the connections. The CONTRACTOR shall notify and schedule the connection with the CITY ENGINEER.

Prior to connecting to existing water mains, the CONTRACTOR shall have all personnel, materials, and equipment ready to connect the fitting to the existing main to keep the shut-off time to a minimum. As soon as possible after making the connections, the CONTRACTOR shall flush the connection to prevent any contamination of the existing facilities. The CONTRACTOR shall take every precaution necessary to prevent dirt or debris from entering the main. The CONTRACTOR must use AWWA standards C651 and C655 for disinfection and flushing for all new water mains. Refer to PWU's current approved service rules for detail on disinfection, flushing, testing, and connections.

3.37.00 FIRE HYDRANT INSTALLATION

Before installation of a hydrant, the following operations shall be performed:

(A) The hydrant shall be thoroughly inspected for any defects or damage.

(B) The hydrant interior shall be thoroughly cleaned.

(C) The hydrant shall be opened and closed as many times as necessary to determine that all parts are in proper working order, valves are seating properly and the drain valve is operating freely.

(D) The hydrant shall be aligned so that the nozzles are rotated to face the accessible route by the Fire Department.

(E) The hydrant bury depth from the shoe to the finished grade shall be verified and the appropriate hydrant installed (see below). Extension kits will not be allowed on new hydrant installations without the prior written approval of the CITY ENGINEER.

(F) When approved, height adjustments must be made by utilizing a grade lock at the hydrant shoe.

Following the installation of fire hydrants and before inspection by the CITY ENGINEER, the CONTRACTOR shall ensure the following:

(A) The nozzle caps are removed, cleaned and greased with a food grade anti-seize compound such as those manufactured by Loctite, CRC, Assured Flow or USA Bluebook, or equal as approved in writing by the CITY ENGINEER.

(B) Reservoir oil is checked and filled as required.

(C) The operating nut is in new condition.

(D) The hydrant is re-painted in accordance with the requirements of Section 3.55.00.

Hydrants shall be set so that a minimum of 5 feet of cover is provided for the lateral line and the nozzles are a minimum of 18 inches above finished grade. Each hydrant shall be set on a concrete foundation at least 18 inches by 18-inches and 6 inches thick. Each hydrant shall be blocked against the end of the trench with a concrete thrust block and shall be mechanically restrained from the tee at the mainline to the hydrant.

Hydrants shall have weep drain holes in the hydrant shoe and shall be surrounded with 1-1/2-inch washed rock. A sheet of 8-mil polyethylene shall be placed over the washed rock to prevent dirt from filling the rock. All hydrants shall stand plumb and shall be connected to the street main by a minimum 6-inch ductile iron lateral line. The lateral line, hydrant and fittings shall be wrapped in polyethylene. For new construction, the hydrant barrel from the flange to the shoe shall be ordered to meet the required field dimension so that the proper depth is achieved without the use of extensions. The fire hydrant traffic flange shall be adjusted to no less than 2 inches and not more than 8 inches above the approved finished grade.

Depending upon hydrant location, the use of steel posts filled with concrete may be required for protection, as required by the CITY ENGINEER. Hydrant gate valves shall have a restrained connection directly to the tee at the main (swivel tee). In areas where the hydrant bottom is installed below ground water, the drain shall be plugged and the hydrant marked with a metal tag to indicate the requirements to pump the hydrant after use. All other requirements shall be as shown on the detail drawing in the Appendix of this chapter.

3.38.00 TAPS

The size of tap and the tapping method for a given type and size of waterline shall be as follows. Transmission mains (16 inch pipes and larger) should not be tapped unless otherwise approved in writing by the CITY ENGINEER.

Host Pipe Size	Tap Size (DIP or PVC)			
	¾”	1”	1-1/2”	2”
6”	DT/S	DT/S	S	S
8”	DT/S	DT/S	S	S
10”	DT/S	DT/S	S	S
12”	DT/S	DT/S	S	S

S -- Tapping saddle required. All saddles shall have the AWWA taper on its threads.

DT -- Direct tap permitted.

DT/S -- Either a tapping saddle or a direct tap may be permitted depending on the situation.

All existing AC waterlines shall be tapped using a saddle.

All ¾" and 1" taps into the water main shall be at an angle of 45 degrees from the horizontal, and corporation stops shall be installed. For 1" and smaller, continuous type K copper shall be used from the main with no joints or valves between the corp stop and meter yoke. 1 1/2" and 2" taps into the water main shall be at the 3 and 9 O'clock position, and corporation stops installed.

Taps shall not be made on a water main until the main has passed the pressure tests and clear water tests and a "Release For Service" letter has been issued by the CITY ENGINEER. Care shall be taken to properly install water service lines so that a minimum of 12 inches of slack is in the service line at the main to protect against pull-out. Tapping mains may require digging out bedding material and cutting or removing part of the corrosion protective wrapping. After the taps are made, the wrap shall be repaired or replaced by the CONTRACTOR to protect both the service line and the main.

Service taps shall have a minimum separation of 24 inches and be no closer than 24 inches to a main line joint. There shall be no more than 4 taps per 20' section of pipe.

All service taps shall be performed by the CONTRACTOR. All necessary materials for said taps, including corporations stops, copper line, meter pits, copper setters, curb stops, etc., shall be supplied by the CONTRACTOR. Said materials shall conform to these STANDARDS AND SPECIFICATIONS. The CITY ENGINEER will inspect each tap prior to backfilling.

Taps to PVC mains shall be accomplished with the mainline valves either side of the tap in the closed position.

Taps to PVC mains shall only be made when the air temperature is 32°F or higher.

3.39.00 METER INSTALLATION

All meter installations shall be in accordance with the detail drawings in the Appendix of this chapter.

No connections shall be made in the meter pit other than those related to the meter and bypass. Sprinkler system or backflow preventer connections shall be made no closer than five (5) feet from the meter pit or vault on the downstream side of the meter. The CITY will own and maintain the service line and fittings up to, and including the meter.

Residential single family meters with transponders shall be provided and installed by the CITY upon the CONTRACTOR'S request for a final meter inspection. All other

meters and associated transponders shall be purchased by the CONTRACTOR and then provided to the CITY for testing prior to installation. The CONTRACTOR shall contact the CITY's Meter Shop prior to purchasing meters and transponders to verify the type and brands that are required. The CONTRACTOR shall also contact the CITY's Meter Shop to make an appointment for delivery of said meter(s) to the Shop for testing. The location of installation and manufacturers information shall accompany the meter when delivered by the CONTRACTOR to the CITY's Meter Shop. The meter will be tested and CONTRACTOR must call to schedule the meter pit/vault inspection. In addition, the following specific criteria shall apply:

3.39.01 3/4-Inch and 1-Inch Meter Installations

The ¾" and 1" meter sets shall be installed in accordance with these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter. The meter shall be located a minimum of 18 inches from the back of walk to the edge of the meter lid. Where no sidewalk exists, the meter shall be placed a maximum of 6 feet behind the back edge of the curb. In detached walk areas the meter shall be placed 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the walk to the edge of the meter lid. In all cases, the meter shall be installed within rights-of-way or public easements. In some situations, the meter set location may be modified as directed by the CITY ENGINEER.

The dome or meter lid shall be level and 2 inches above the approved final grade. The copper setter shall be a minimum of 15 inches and a maximum of 17 inches below the meter pit lid. A variance of more than 2 inches vertically in installing the copper setter will not be accepted.

No meters shall be set in streets, sidewalks, driveway alignments, or concrete areas without specific design and prior approval of the CITY ENGINEER. Meter pits shall be constructed of modified hi-density polyethylene. The size shall be as specified in the detail drawing in the appendix of this chapter. Grade adjustment shall be made at the top of the pit using concrete rings. The trench floor under the concrete rings shall be compacted earth. The concrete pit shall not bear on the service pipe.

Final inspections of the meter pit will be made at the time the meter is actually set. The building permit applicant is responsible for any required adjustments to the copper setter or meter lid at that time.

3.39.02 1-1/2-Inch and 2-Inch Meter Installations

The 1 ½" and 2" meter sets shall be installed in accordance with these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter. Meter manhole lids shall be a maximum of 2 inches above the approved final grade.

The meter manhole shall be located a minimum of 3 feet behind sidewalk and in no case shall the manhole lid be located more than 10 feet from the back edge of curb. Where no sidewalk exists, the meter shall be placed a

maximum of 6 feet behind the back of curb. In detached walk areas the meter shall be placed 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the walk to the edge of the meter lid. A curb stop is required on the service line behind the back of curb and outside of the manhole. In all cases, the meter manhole shall be installed within the right-of-way or public Utility Easements. No meter manholes shall be set in streets, concrete areas, driveway alignments, or other traffic area without specific design and prior approval of the CITY ENGINEER.

Meter manholes shall use a 24 inch aluminum ring and cover and the outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set then a 12" wide by 6" thick concrete collar shall be placed around the manhole ring. The manhole cover shall have a 2 inch diameter recessed hole in the center of the cover for the transponder and the cover shall have the lettering "Water Meter" cast into the lid. Meter manholes in traffic areas are only allowed at the discretion of the CITY ENGINEER. If allowed, the manhole shall use a 24 inch aluminum ring and cover and shall be designed to accommodate and protect the transponder. Approval by the CITY ENGINEER of this design will be on a project specific basis.

3.39.03 3-Inch and Larger Meter Installations

The 3" and larger meter sets shall be installed in accordance with these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter. The entry hole through the roof of the vault shall be aligned perpendicular to the service line and adjacent to the water meter. Vaults shall be sealed at all joints and made watertight. Meter vault lids shall be a maximum of 2 inches above the approved final grade.

The meter vault shall be located a minimum of 5 feet behind sidewalk or back of curb and no more than 10 feet from the back of curb. Where no sidewalk exists, the meter shall be placed a maximum of 6 feet behind the back of curb. In detached walk areas the meter shall be placed 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the walk to the edge of the meter lid. A curb stop is required on the service line behind the back of curb and outside of the vault. In all cases, the meter vault shall be installed within the right-of-way or public Utility Easements. No meter vaults shall be set in streets, concrete areas, driveway alignments, or other traffic area without prior approval of the CITY ENGINEER.

Meter vaults shall use a 24 inch aluminum cover and shall have the lettering "Water Meter" cast into the lid. A 24" x 36" aluminum cover adaptor and ring shall be used to enlarge the access opening and the adaptor shall have a 2 inch diameter hole for the transponder.

The outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set then a 12" wide by 6" thick concrete collar shall be placed around the manhole ring. Meter manholes in traffic areas are only allowed at the discretion of the CITY ENGINEER.. Approval by the CITY ENGINEER of the design for traffic areas will be on a project-specific basis.

PVC pipe shall be used on the service line outside the vault, except where the pipe stubs through the vault walls. DIP shall be used inside the vault. For all 3 inch and 4 inch meter settings, 4 inch service pipe will be required on the CITY side of the meter. A reducer will be required before the meter and on the bypass for 3 inch settings. Insulators shall be provided between connections of dissimilar metals. Meter installations 3" and larger shall require shop drawing submittals for approval.

Final inspections of the meter manhole will be made at the time the meter is set. Meter will be set by the CONTRACTOR if the meter manhole passes inspection. CONTRACTOR must call 303-658-2549 to schedule final inspection. CONTRACTOR will warranty meter manhole and appurtances for a period of 2 years after final inspection has passed.

3.40.00 TESTS

3.40.01 General

The CONTRACTOR shall disinfect and test all mains and fire lines regardless of existing conditions. This may include repairing existing facilities that must be included in the test and are not capable of holding test pressures. All thrust blocks or other bracing facilities shall be in place at least 48 hours before the initial filling of the line. All tests will be observed by the CITY INSPECTOR.

3.40.02 Filling and Venting Lines

All valves will be operated by the PWU. The line shall be slowly filled with water and all air expelled from the pipe. Care shall be taken so that all available hydrants (including hydrant gate valves), air valves, and other vents are open during the filling of the line. Where hydrants or other vents are not available in the line, the CONTRACTOR shall make whatever taps are required for venting purposes. These taps shall be abandoned after pressure and disinfection tests have passed and the line has been completely flushed as required by the PWU. Following testing, the taps shall be removed back to the main and the main repaired by the use of a stainless steel repair clamp. The rate of filling the line shall not exceed the venting capacity of the vent.

3.40.03 Disinfection

The CONTRACTOR will be required to disinfect all new water piping (mains, services, hydrant laterals, etc.), connections to the existing water system and water main breaks in accordance with AWWA standards C651 and C655. Disinfection of the water system shall be performed after all field placed concrete has fully cured, in accordance with Section 3.35.00 of these STANDARDS AND SPECIFICATIONS, and following backfill of the water system. The CITY ENGINEER shall be notified at least 48 hours prior to disinfection or flushing is performed. All new water piping must be disinfected and receive approval by the CITY prior to connection to the existing system, unless written approval is provided by the CITY ENGINEER.

Any exceptions to the AWWA standards will be outlined in the PWU Department Service Rules or must be approved in writing by PWU.

If a connection or repair is made to an existing water main with an equivalent length equal to or less than 18 feet of pipe, the new pipe, fittings and valves required for the connection shall be spray-disinfected or swabbed with a minimum 1 percent solution of chlorine just prior to being installed in accordance with AWWA C651-, Section 10. If possible, flushing from both directions toward the work area shall be performed immediately following repairs.

3.40.04 Flushing the Main

The CONTRACTOR shall dechlorinate the water prior to flushing the line.

The entire line shall be flushed after the specified disinfection time as required in Section 3.40.03. Such flushing shall continue until the water is clear and meets the chlorine content of the existing line. The entire line, including hydrant leads, branch lines, and dead-end mains shall be flushed. The discharge of flushed water shall be accomplished such that no erosion will occur and with no harm to fish, animals, or plants in accordance with Federal and State regulatory agencies. The Water Quality Control Division of the CDPHE requires all CONTRACTORS to possess a current Discharge Permit for discharges of chlorinated and process waters associated with the installation of new mains or conduits. Contact CDPHE Water Quality Control Division at 303-692-3539 for information on obtaining the required permit. Procedures for discharge will be subject to the review of the CITY ENGINEER.

3.40.05 Pressure Test

After the pipe and appurtenances have been laid, the line has been backfilled, and all field-place concrete has cured in accordance with Section 3.35.00 of these STANDARDS AND SPECIFICATIONS each valved section, unless otherwise directed by the CITY ENGINEER, shall be subjected to a hydrostatic pressure of not less than 150 psi. However, in all cases the test pressure shall be 50 percent over existing main pressure in the test area as measured at the lowest elevation of the water main. The test duration shall be a minimum of one hour. If the test pressure drops more than 5 p.s.i. during the test, measured water shall be added to the test section to bring the section up to the specified test pressure. Water added to maintain the pressure shall be per AWWA C600 and AWWA C605. Allowable leakage shall be calculated according to the following formula:

Ductile Iron and PVC Pipe:

$$L = \frac{N \times D \times \sqrt{P}}{148{,}000}$$

L = Allowable Leakage in gallons per hour
N = Total length of pipe being tested in feet
D = Nominal diameter of pipe in inches
P = The average test pressure in psi

Each test section of pipe 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 connected to the pipe in a satisfactory manner. The pump, pipe connection, gauges, and all necessary apparatus and labor shall be furnished by the CONTRACTOR. Gauges and measuring devices shall be approved by the CITY ENGINEER. Before applying the specified test pressure all air shall be expelled from the pipe. Any cracked or defective pipes, fittings, valves, or hydrants discovered in the pressure test shall be removed and replaced by the CONTRACTOR with sound material including any existing pipe or appurtenances that are leaking and were included in the test section. After all visible leaks have been repaired; the pressure test shall be conducted again. Should testing show a leakage rate in excess of the rates calculated from the formula above, the pipeline shall not be accepted. The pipeline shall be repaired, rechlorinated to meet the criteria in Section 3.40.03 of these STANDARDS AND SPECIFICATIONS and retested as described in this section until it meets the test requirements and is accepted by the CITY ENGINEER.

3.40.06 Bacteriological and Turbidity Test

Water from all new water mains and appurtenances must successfully pass a bacteriological and turbidity test before the main is placed in service. After final flushing, an acceptable sample shall be collected from the new mains and appurtenances. A sample shall be collected for every 1200ft of new pipe.

All sampling shall be performed by the PWUPWU. A minimum 24 hours is required to receive bacteriological test results and may take as long as 72 hours. No bacteriological tests will be taken on Thursdays or Fridays.

If unsatisfactory results are obtained from bacteriological tests, the water system shall be rechlorinated by the continuous-feed or slug method of chlorination in accordance with AWWA C651 current revision, Section 8, until satisfactory results are obtained. Rechlorination shall be done by the CONTRACTOR, at their expense and under the CITY ENGINEER's supervision. If coliform is present in the results, the CONTRACTOR is required to pass two (2) successive tests.

3.40.07 Cathodic Protection System Testing

Following construction of water mains and other appurtenances requiring cathodic protection, the following tests shall be performed:

1. Test the pipe-to-soil voltage potential by comparing to a copper sulfate half-cell. One lead of the volt meter is connected to the pipe lead and the other is connected to the copper sulfate half cell buried in moist in-situ soil near the pipe installation. The potential shall read 0.85 volt or higher. A value of 0.80 volts or less means the pipe is corroding.

2. Check the continuity of the pipe. Prior to completely backfilling the pipe an ohmmeter shall be connected between each end of the installed pipe to measure an ohm reading. Next, test between the test

box lead wire and the pipe. A reading of 3 ohms or less shall be achieved for both tests.

3. Test the voltage output of the anode. As in test one above, connect the voltmeter to the anode lead wire and the other lead to the copper sulfate half cell. The voltage reading shall be between 1.4 and 1.6 volts.

4. Measure the current flow from the anode to the pipe. The volt meter is connected to the anode test lead and the other voltmeter lead is connected to the pipe test lead in the test box. The reading shall be between 0.005 amp and 0.3 amp. If the current is more than 1.3 times the design needs, a resistance shall be added to the circuit to extend the life of the anodes.

3.41.00 WORKING WITH ASBESTOS CEMENT PIPE

Approximately one-third of the CITY's distribution system is asbestos-cement (AC) pipe, commonly known as "Transite." When working with AC pipe by tapping, removing portions of the pipe, attaching fittings or disposing of the pipe, certain precautions need to be taken. The CONTRACTOR shall pothole to determine the AC pipe outside diameter. It will be the responsibility of the CONTRACTOR working within the CITY of Westminster to follow State and Federal regulations (such as CDPHE, Regulation 8 Part B) as they apply to asbestos materials.

3.42.00 ABANDONMENT PROCEDURES

Abandonment of CITY water facilities shall follow these procedures. The CITY ENGINEER shall approve of facilities to be abandoned, and the method and materials used for the abandonment.

Water Services:

- Expose the tap at the main line connection.
- Disconnect the service line from the corporation stop and pull the service line away from the main.
- Remove the corporation stop and install an approved repair clamp on the main.
- Rewrap Cast Iron or Ductile Iron Pipe with polyethylene and tape.
- After inspection, backfill and compact the excavation.
- Remove the meter and yoke from the meter pit and return the meter to the CITY's Meter Shop.
- Remove the meter pit cover and contact the CITY'S Meter Shop to return cover.
- Backfill the meter pit and compact the excavation to finished grade
- Meter pit removal may be required*

Water Lines:

- Shut down the main and remove a section of pipe.
- Any main and fittings that will remain in service shall be disinfected in accordance with Section 3.40.03.

- Plug the pipe or fitting and rewrap Cast Iron or Ductile Iron Pipe with polyethylene and tape.
- Install required thrust block.
- Pressure grout the abandoned water line, or other methods approved by the CITY ENGINEER.
- If removing water line at active tee, remove tee and replace existing water line with new pipe section.

Water Valve Boxes:

- Water valves to be abandoned shall be removed in their entirety with a blind flange installed at the fitting.

3.50.00 MATERIALS

3.51.00 GENERAL

With the exception of fire hydrant laterals, only polyvinyl chloride (PVC) pipe is approved for water distribution main installations. Any other material proposed must be approved by the CITY ENGINEER in writing, prior to construction. All materials furnished shall be new and undamaged.

Acceptance of materials or the waiving of inspection thereof shall in no way relieve the Developer of the responsibility for furnishing materials meeting the requirements of these STANDARDS AND SPECIFICATIONS. The CITY reserves the right to direct or deny the use of certain types of materials in specific circumstances. All materials delivered to the job site shall be adequately housed and protected to ensure the preservation of their quality for the work. The presence of any defects in any materials may constitute sufficient cause for rejection of the pipe or appurtenances. Rejected materials shall be removed from the work site unless otherwise permitted by the CITY ENGINEER.

3.52.00 PIPE

3.52.01 Ductile Iron Pipe (DIP)

All ductile iron pipe shall be manufactured in accordance with AWWA Standard C-151 current standard (include zinc coated pipe), Ductile Iron Pipe Centrifugally Cast for Water. Pipe furnished under this specification shall conform to pressure class 350.

Ductile iron pipe shall be approved for fire hydrant laterals, pipe stubs through walls (as required) and other applications as approved by the CITY ENGINEER in writing.

The joint type shall be "push-on, single-gasket" type conforming with applicable requirements of AWWA Standard C-111 current standard, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings. Joint types other than "push-on, single-gasket" are acceptable only if specifically approved by the CITY ENGINEER in writing.

Pipe shall have normal laying length of either 18 feet or 20 feet. Random lengths are not acceptable.

Grade of Iron used in the manufacture of pipe shall have 60/42/10 physicals in accordance with AWWA C-151.

Pipe shall have standard thickness cement mortar linings in accordance with AWWA Standard C-104-13, Cement Mortar Lining for Ductile Iron Pipe and Fittings. Pipe shall have a standard asphaltic coating on the exterior

The weight, pressure class or nominal thickness, and casting period shall be shown on each pipe. The manufacturer's mark, the year in which the pipe was produced, and the letters "DI" or

"Ductile" shall be cast or stamped on the pipe. IAW AWWA C-151 current standard.

3.52.02 Polyvinyl Chloride Pipe (PVC)

All PVC pipe shall meet the requirements of AWWA Specification C-900 current standard, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (4" - 12"), and shall be Pressure Class 305 psi (DR 14), or AWWA C-905 current standard, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (14" - 48"), and shall be Pressure Class 235 psi (DR 18).

All pipe shall be suitable for use as a pressure conduit. Provisions must be made for expansion and contraction at each joint with a rubber ring. The bell shall consist of an integral wall section with a solid cross-section rubber ring which meets the requirements of AWWA Specification C-900 current standard.

Standard laying lengths shall be twenty feet (20') for all sizes. Random lengths shall not be acceptable.

Each length of pipe shall bear the date manufactured, type, grade, length, manufacturer's name, and NSF seal of approval.

Pipe joints shall be made using an integral bell with an elastomeric gasket push-on type joint or using machined couplings of a sleeve type with rubber ring gaskets and machined pipe ends to form a push-on type joint.

Solvent cement joints are strictly prohibited.

The manufacturer shall furnish a certified statement that all of the specified tests and inspections have been made and the results thereof comply with the requirements of the applicable standard(s) herein specified. A copy of the certification shall be sent to the CITY ENGINEER upon request.

The following test station box has been approved by the CITY for use with tracer wire installations:

Valvco, Terminal Box #NM (5" ID) without locking lid
Others as approved in writing.

3.52.03 Steel Pipe

Upon approval by the CITY ENGINEER, the use of steel pipe may be allowed for transmission mains 16 inches in diameter or larger. The pipe shall meet Standard AWWA C-200 current standard, Steel Water Pipe 6 inch and Larger, and installed accordingly. Detailed specifications shall be as approved by the CITY ENGINEER on a case-by-case basis.

All new steel mains shall require cathodic protection and shall be designed by a qualified cathodic protection engineer, registered in the State of Colorado. Cathodically protected pipe shall also require polyethylene wrap as described in Section 3.61.02.

3.53.00 FITTINGS

All mechanical joint fittings shall be manufactured in accordance with AWWA C110 current standard, Ductile Iron and Gray Iron Fittings, or AWWA C153 current standard, Ductile Iron Compact Fittings. Fittings shall be furnished with rubber gasket joints in accordance with AWWA C111 current standard, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

All fittings shall be 350 PSI pressure rating and shall conform to the dimensions and weights shown in the tables of the above referenced AWWA Standards. All fittings shall be made from gray iron or ductile iron. The manufacturer shall prepare a certified statement that the inspection and all of the specified tests have been made and the results thereof comply with the requirements of the applicable Standard(s) herein specified. A copy of the certification shall be sent to the CITY ENGINEER upon request.

All ductile iron flanged fittings shall be manufactured in accordance with AWWA C110 current standard for integrally cast flange fittings or AWWA C115 current standard, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges, for threaded flange fittings. Typical ductile iron flanged fittings shall be rated for 250 psi working pressure. A working pressure of 350 psi may be achieved with the use of special gaskets.

The following are additional requirements or exceptions to the standards mentioned above:

All fittings 4" through 16" shall be furnished with a fusion bonded epoxy inside and out, with a standard thickness as defined in AWWA C116 current standard , Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings. The requirement for fusion bonded epoxy on fittings may be waived by the CITY ENGINEER if specific fittings are not available.

All fittings shall be furnished complete with tee-head mechanical joint bolts and hexagon nuts and shall be fabricated from a high strength, low alloy steel known in the industry as "Cor-Ten" or approved equal.

Mechanical joint anchoring fittings (swivel) as approved by the CITY ENGINEER, in writing, may also be used.

3.54.00 VALVES

3.54.01 General

All valves shall open left (counterclockwise). Valves shall have a 2-inch-square operating nut. Extension stems shall be pinned to the operating nut for a secure connection. Set screw type connections will not be allowed.

All buried valves shall be installed with a valve box meeting the material specifications of Section 3.54.04 of these STANDARDS AND SPECIFICATIONS.

3.54.02 Gate Valves

Gate valves shall be required for 4 inch through 12 inch valve sizes, unless approved otherwise by the CITY ENGINEER in writing. Gate valves shall be iron body, resilient-seated gate valves with non-rising bronze stems with design, construction, and pressure ratings conforming to AWWA Specifications C-509 current standard, Resilient Seated Gate Valves, or C515 current standard, Reduced Wall Resilient
Seated Gate Valves, and with modifications specified herein. Stem seals shall be triple "O" ring seals designed so that the seals above the stem collar can be replaced with the valve under pressure and in full open position.

Gate valves approved by the CITY shall be one of the following types:

American Flow Control, Series 2500 (C515 only)
Mueller, Series 2361, 2362
American AVK, Series 25, 45, 65
CLOW Valves, Models 2639 and 2640

With the exception of tapping valves and valves in vaults, gate valves shall have mechanical joint ends.

Gate valves requiring flanged ends shall have dimensions and drilled holes that conform to ANSI B16.1, Class 125. Flange faces shall be machined to a flat surface with a serrated finish in accordance with AWWA C207 current standard, Steel Pipe Flanges (4 in. through 144 in). Tapping valves and valves in water vaults for 3" and larger meters shall have a flange connection on one side of the valve and a mechanical joint on the other side (refer to Section
3.60.04 for approved tapping valves).

All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116 current standard, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray

Iron Fittings, and C550 current standard, Protective Interior Coatings for Valves and Hydrants. The coating shall be a two-part thermosetting epoxy suitable for field over coating and for touch-up with the same coating material without special surface preparation. The supplier shall furnish detailed performance tests of adhesion, hardness and abrasion resistance of the furnished coatings when requested by the CITY ENGINEER. The coating shall have a successful record of performance in valves, pipe or other fittings for a minimum of ten years.

The resilient seat gate valve stem shall have external break-off capabilities for over-torquing and positive stop to prevent over compression.

All external bolts, nuts and washers used in conjunction with valves shall be stainless steel and tee-bolts shall be "Cor-Ten" with zinc caps with wax tape coating. Valves shall be delivered complete with bolts, glands and rubber gaskets in conformance with AWWA C111 current standard, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

3.54.03 Butterfly Valves

Butterfly valves shall be required for 16 inch and larger valves, unless approved otherwise by the CITY ENGINEER in writing. All butterfly valves shall be installed in a vault in accordance with the detail drawings in the Appendix of this chapter. Butterfly valves shall have a combination air and vacuum valve installed on both sides of the valve.

Butterfly valves approved by the CITY shall be one of the following types:

Mueller, Lineseal III and XPII (sizes up to 48”)
Pratt, Triton XR-70 (sizes 24” to 72”),
K-Flo, 500 Series (sizes up to 20”)

Butterfly valves shall be geared and designed for underground service and shall conform to current AWWA Specification, Rubber Seated Butterfly Valves, Class 150-B. Valves shall be tight closing rubber seat type with the rubber seats bonded to the valve body. No metal to metal sealing surfaces will be permitted. Valves shall be bubble tight to 150 PSI minimum rated pressure with flow in either direction. Valve discs shall rotate 90 degrees from the full open position to the shut-tight position. Valve bearings shall be sleeve-type corrosion-resistant, and self-lubricating with the load not to exceed 2,500 PSI.

All butterfly valves shall be furnished with flanged ends. Dimensions and drilling shall conform to ANSI B16.1, Class 125. Flanges shall be machined to a flat surface with a serrated finish in accordance with AWWA C207 current standard, Steel Pipe Flanges (4 in through 144 in). The flanges shall have full-sized bolt holes through the flanges, except that drilled and tapped holes will be acceptable only in the areas where the shaft passes through the body. Flanges with all holes tapped will not be allowed.

All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116 current standard, Protective Fusion Bonded

Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550 current standard, Protective Interior Coatings for Valves and Hydrants.

All external bolts, nuts and washers used in conjunction with valves shall be stainless steel and tee-bolts shall be "Cor-Ten".

3.54.04 Valve Boxes

Valve box risers for standard bury depths shall be two-piece with a 5-1/4-inch diameter screw-type shaft that is adjustable from 45 inches to 60 inches in height. Extensions shall be required for pipes with greater bury depth and the number of extensions shall be minimized. Valve boxes shall be made of gray cast-iron with a large oval base and conform with ASTM A48 Class 30A. Valve boxes shall be considered integral units and shall have at least 6 inches adjustment above and below the specified depth of cover over the pipe. Valve box lids shall be marked with the word "WATER," and shall have a lip or flange extending into the valve box shaft. No slip-type boxes will be allowed.

Valve boxes for buried gate valves shall be one of the following types as approved by the CITY:

Tyler, series 6860 (with No. 160 base)
Olympic Foundry Inc., Model No. 450VB
Castings Inc., Series 6850
East Jordan Iron Works, Series 8560

3.55.00 FIRE HYDRANTS

Hydrants will be Waterous, Pacer Model WB-67-250 with the following options:

-- Bronze to bronze seating.
-- Oil cup reservoir.
-- Bronze "safety sleeve" stem coupling.
-- Bronze operating nut.
-- Epoxy-coated upper and lower washer assembly.
-- Fire hydrants shall open left (counterclockwise).

Hydrants shall have a 5-1/4-inch main opening with a 6-inch mechanical joint end. Each hydrant shall be equipped with one 4-1/2-inch pumper nozzle and two 2-1/2-inch hose nozzles with national standard threads. A traffic break-away feature shall be incorporated into the barrel of the hydrant at the ground line.

Hydrants shall be thoroughly cleaned at the factory and then painted with a prime coat of synthetic red primer, Type IV-TTP-86f, followed by one shop coat of fire engine red industrial enamel (Rust-oleum 7407 masstone tint base #1210, or approved equal). Fire hydrant paint shall not be lead based. Care shall be taken when handling hydrants to protect the paint. The installation CONTRACTOR shall repaint all hydrants after installation with Rustoleum brand High Performance Protective Enamel (7564 Safety Red), as determined by the CITY ENGINEER.

The operating nut shall be National Standard pentagon measuring 1-1/2 inches from point to opposite flat. Nozzle covers shall have the same size and shape nut as the operating nut and shall be attached by chain to the hydrant body.

Any product that must be modified to meet these STANDARDS AND SPECIFICATIONS shall be accompanied by a certification signed by a company officer that states that these changes have been incorporated into the product furnished and, in addition, the hydrant shall be tagged by the manufacturer to assure that all the above options were included.

3.56.00 BLOW-OFFS

For host pipes 12" in diameter and below, blow-offs shall consist of a 2" threaded CC, a 2" gate valve, a 2" blow off pipe, and a blow-off assembly approved by the CITY. Refer to the detail drawing in the appendix of this chapter. On a dead end main, a reducer down to 4-6" and a Tee with a 2"female IPT shall be installed. With a 1' 6" brass IPT to a 2" gate valve and a minimum of 4' IPT brass to a 90-degree fitting and a standpipe no less than 12" from the ground surface.

The standard required blow-off for 16-inch and larger mains shall be a 6-inch or larger pipe with a gate valve meeting the material requirements of Section 3.54.02 of these STANDARDS AND SPECIFICATION and a manhole meeting the material requirements of Section 3.57.00 of these STANDARDS AND SPECIFICATIONS. This blow-off shall also conform to the detail drawing in the Appendix of these STANDARDS AND SPECIFICATIONS.

3.57.00 MANHOLES AND VAULTS

3.57.01 General

Manholes, Vaults and associated components (i.e. manhole sections, lids, walls and base slabs) shall be designed in accordance with ASTM C 857 and ASTM C 858 to handle applicable loads, including earth, thrust and live loads. Concrete shall have a minimum 28 day mix design of 5,000 psi. All concrete structures shall be designed for HS-20 loading in accordance with AASHTO Standards. Concrete structures shall be manufactured by facilities certified by the National Precast Concrete Association (NPCA). Concentric reducing sections for manholes shall not be used.

Vaults shall be cast with a separate roof slab for removal and shall be 8 inches minimum thickness. Vault walls shall be cast in one continuous placement and corners shall have added reinforcement as shown in the standard detail in the appendix of these Standards and Specifications. Minimum wall thickness shall be 6 inches and reinforcement shall be at least one inch from the face of the vault. Shop drawings for vault designs shall be submitted to the CITY ENGINEER and shall be signed and sealed by a Registered Professional Engineer in the State of Colorado.

Steps shall be ½" minimum diameter steel reinforcing bar with a polypropylene plastic covering. Steps shall be placed 12 inches on center and 18 inches maximum from the top of the ring to the first step. Steps shall align with one another in a straight vertical line. Steps shall be PS2-PF manufactured by M.A. Industries, Inc., or CITY approved equal.

3.57.02 Rings and Covers

All gray iron manhole rings and covers shall conform to the requirements of AASHTO M 105 Class 35B or ASTM A48 Class 35B. Ductile Iron castings shall conform to the requirements of ASTM A536 Grade 80-55-06. Aluminum castings shall conform to the requirements of ASTM B 26 Alloy 356 or 319. All castings shall conform to Federal Specification RR-F-621E, for shape and dimension required and shall have a minimum traffic load rating of AASHTO H20-44.

Each casting shall have markings by the foundry showing: name of foundry, country of manufacture, AASHTO or ASTM designation number, Class number and letter and cast date. Lids shall have lettering, and CITY logo, as shown in the detail drawings in the appendix of this chapter. CITY logo is required on all castings except valve box covers and meter pit lids for meters 2 inch and smaller.

Castings shall be free from plugging, sand, blowholes, shrinkage, cracks, and other cold shuts and be well cleaned by shot blasting. Runners, risers, fins, and other cast-on pieces shall be removed from the castings and ground smooth. Bearing surfaces between manhole rings and covers shall be cast or machined with such precision that a uniform bearing surface shall be provided throughout the perimeter area of contact.

Covers shall be 23-7/8" in diameter and frame or ring height shall be 8" tall in accordance with the standard detail in the appendix of these STANDARDS AND SPECIFICATIONS, or as otherwise approved in writing by the CITY ENGINEER. Concrete extension collars shall be used to adjust the manhole ring and cover to approved street or ground surface.

Gray iron ring and covers shall be the following type or CITY approved equal:

East Jordan Iron Works, No. 00240568 (cover); No. 00242011 (ring)

Water meter vaults for 3" and larger services and butterfly valve vaults shall have a 24" x 36"
cover adaptor ring to enlarge the access opening as shown on the detail drawings in the appendix of this chapter. Meter vaults must have an aluminum 24" X 36" cover and adaptor. Adaptor rings for meter vaults shall have a 2-inch diameter machined hole and there shall be a 3-1/2-inch diameter recessed area above the hole so that the transponder can be installed flush with the surface pattern of the lid.

Gray iron 24" x 36" adaptor rings shall be the following type or CITY approved equal:

East Jordan Iron Works, No. 2455E (adaptor); No. 2455Z (ring)
D & L Foundry, No. A-1425 (adaptor and ring)

Water meter manholes for 1-1/2" and 2" services shall have aluminum rings and covers. The covers shall have a 2-inch diameter machined hole and there shall be a 3-1/2-inch diameter recessed area above the hole so that the transponder can be installed flush with the surface pattern of the lid. Aluminum rings and covers shall not be allowed in traffic areas.

Aluminum rings and covers shall be the following type or CITY approved equal:

Castings Inc., Model MH-100-24 AL

All manholes and vaults installed in "field conditions" or in areas prone to tampering shall have locking covers and shall have gaskets for a water tight seal to prevent inflow. Locking lids shall be ductile iron. Bolt down type locking covers will not be accepted.

Locking type rings and covers shall be approved by CITY ENGINEER.

3.57.03 Base Slabs and Base Beams

When required, manhole base beams shall be precast, reinforced concrete. The beams shall be 12 inches wide by 9 inches deep by 8 feet long. The reinforcement shall consist of three No. 5 bars longitudinally and No. 4 bars at 12-inch centers transversely.

Base slabs may be poured in place or precast. The slab shall be designed to uniformly support AASHTO H-20 traffic loading and any earth loading. The minimum slab thickness shall be 6 inches. The minimum reinforcement in the base slab shall conform to the detail drawings in the Appendix of this chapter.

3.57.04 Joint Material

Joint material used to join all sections shall be a flexible butyl resin joint sealing compound meeting Federal specifications SS-S-210-A and AASHTO M-198-B. Joint material shall be Conseal CS-102 manufactured by Concrete Sealants, Inc., or CITY approved equal.

3.57.05 Mortar

Mortar used in repair of precast sections and for grouting joints shall be composed of one part Portland cement and not more than three nor less than two parts of fine aggregate. Hydrated lime or masonry cement shall not be used. Portland cement shall meet the requirements of ASTM C-250, Type II. Fine aggregate shall consist of well-graded natural sand having clean, hard, durable, uncoated grains, free from organic matter, soft or flaky fragments or other deleterious substances. The fine aggregate shall be thoroughly washed

and shall be uniformly graded from coarse to fine with a minimum of 95 percent passing a No. 4 sieve and a maximum of 7 percent passing a No. 100 sieve.

3.58.00 VAULT ELECTRICAL AND MECHANICAL

SECTION NOT USED

3.59.00 VENT PIPES

For typical above ground vent pipe installations, vent pipes shall be 3-feet tall and 8-inch diameter seamless pipe in accordance with the details in the appendix of these STANDARDS AND SPECIFICATIONS.

Below-ground, vent pipes shall be 6-inch diameter, SDR 35 or Schedule 40 PVC in accordance with the details in the Appendix of these STANDARDS AND SPECIFICATIONS. (Update detail W-28)

3.60.00 SERVICE CONNECTIONS

3.60.01 Pipe

Acceptable material for ¾" through 2" service lines is seamless copper tube and for 4" and larger service lines polyvinyl chloride (PVC) pipe shall be used. All service pipes shall conform to one of the following specifications.

(A) Seamless copper tube designated as "Type K" (soft) in the industry shall be used for ¾", 1", 1-1/2" and 2" service lines. Service pipe and fittings 1-1/4" in diameter are prohibited.

(B) Polyvinyl chloride pipe conforming to Section 3.52.02 of these STANDARDS AND SPECIFICATIONS shall be used for 4-inch and larger service lines. Three-inch service pipe is not readily available and service pipe specified as 3-inch shall be upsized to 4-inch from the main connection to the meter pit.

3.60.02 Saddles

For ¾" to 2" taps requiring saddles, the saddles shall be AWWA taper thread (CC thread) and shall be manufactured in accordance with AWWA C-800 current standard, Underground Service Line Valves and Fittings. Cast saddle top, strap, and nuts shall be constructed of ASTM A-536 Class 65-45-12 stainless steel.

The following saddles have been approved for use with ductile iron, cast iron, AC or PVC host pipes, 6" through 12":

	¾"	1	1½"	2"
McDonald	3825 Series			

Ford	FC202-905 Series
Mueller	BR2B Series

3.60.03 Curb Stop Valves and Curb Stop Boxes

All curb stops shall be manufactured in accordance with (Current) AWWA C800 current standard, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62. Curb stop valves shall be ball type with a maximum working pressure of 300 psi and shall have compression fittings.

Curb stop valves for use with copper service pipe shall be the following type or CITY approved equal:

	¾"	1	1½"	2"
McDonald	n/a	n/a	6100Q	6100Q
Ford	n/a	n/a	B44-666-G	B44-777-G
Mueller	n/a	n/a	B-25209	B-25209

All curb stops shall have a valve box per Section 3.54.04.

3.60.04 Tapping Sleeve and Valve

Tapping sleeves shall be required on existing host pipe for all taps larger than 2 inch, unless a tee is provided**.**

Cast or Ductile Iron Host Pipe

Full body Mechanical Joint (MJ) cast or ductile iron tapping sleeves are required.

Tapping sleeves for Cast Iron or Ductile Iron shall be the following type or CITY approved equal:

Mueller H-615
Waterous Series 1004 or 2800
US Pipe T-9
Tyler/Union Compact (up to 12")

PVC or AC Host Pipe

Fabricated stainless steel triangular sidebar style with stainless steel flange tapping sleeves are required. No coated carbon steel saddles will be allowed. A flange insulator kit between the valve and sleeve is required. Stainless steel bolts will be required on the tapping sleeve side of the valve. Tapping sleeve shall be rated for 250 PSI minimum operating pressure (sizes 4"-12") and 200 PSI minimum operating pressure for larger sizes.

Tapping sleeves for PVC or AC host pipes shall be the following type or CITY approved equal:

JCM 432 or 452
Mueller H-304
Ford FTSS
Romac SST III or STS 420
Smith Blair 665

Steel Host Pipe
Weld on Saddles shall be required. These taps are application specific and require approval by the CITY ENGINEER.

Tapping valves shall be resilient seat, cast iron or ductile iron body, fully bronze mounted with non-rising stem and shall be in conformance with Section 3.54.02 of these STANDARDS AND SPECIFICATIONS. Tapping valves shall have a flange connection on one side meeting the requirements of ANSI B16.1 Class 125 and a mechanical joint on the other side meeting AWWA C111 current standard, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings. Valves shall be delivered complete with bolts and gaskets.

Tapping sleeves for Steel host pipes shall be the following type or CITY approved equal:

Mueller, Series 2360 (sizes 4" – 12")

American AVK, Series 45 (sizes 4" – 12")

3.60.05 Corporation Stops

All corporation stops and threaded brass fittings shall be manufactured in accordance with AWWA C800 current standard, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62. All corporation stops shall be tested at the factory and shall meet the following minimum physical requirements:

Tensile strength	30,000 PSI minimum
Yield Strength	14,000 PSI minimum
Elongation in 2 inches	20 percent minimum

Corporation stops shall be ball valve type designed for a maximum working pressure of 300 psi. The inlet side shall have AWWA taper thread (CC thread) and the outlet side shall have a compression fitting.

Corporation stops shall be the following type or CITY approved equal:

	¾"	1	1½"	2"
McDonald	4701BQ			
Ford	FB1000-3-G	FB1000-4-G	FB1000-6-G	FB1000-7-G
Mueller	B-25008			

3.60.06 Stop and Waste

Stop and waste valves must be approved by the CITY ENGINEER. For irrigation systems, a stop and waste valve must be installed between the meter and backflow prevention assembly, and it must be a minimum of 5' downstream of the meter.

3.60.07 Compression Couplings

Only compression fittings will be allowed on copper service pipe. All compression couplings shall be manufactured in accordance with AWWA C800 current standard, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62.

Compression couplings shall be the following type or CITY approved equal:

Ford: C44-G Series (Grip Joint Connection)
McDonald: 74758-22
Mueller: H-15403

Upsizing of service lines after the meter shall be in accordance with the detail drawing of this chapter. Compression couplings for upsizing shall be the following type or CITY approved equal:

	¾" to 1"	1" to 1-1/2"	1½" to 2"	2" to 3"
McDonald	74758-22-33	74758-22-33	n/a	n/a
Ford	C44-34-G-NL	C44-46-G-NL	C44-67-G-NL	n/a
Mueller	H-15403	H-15403	H-15403	H-15403

3.61.00 ENCASEMENT

3.61.01 Concrete

All concrete shall be a minimum of Class D and shall conform Chapter 7 of these STANDARDS AND SPECIFICATIONS. All concrete encasements shall be a minimum of 6 inches thick from outside of pipe to outside of encasement. Reinforcement for pipe encasements shall include #4 "hoop" reinforcement steel on 12" centers transverse and longitudinal #4 reinforcement placement shall conform with detail W27 of these STANDARDS AND SPECIFICATIONS. Material properties for reinforcing steel shall conform with Section 3.67.00 of these STANDARDS AND SPECIFICATIONS.

3.61.02 Polyethylene Encasement

Polyethylene encasement material shall be a minimum of 8 mils thick and shall be a high density, cross-laminated polyethylene film. All polyethylene encasement material shall be manufactured in accordance with ANSI/AWWA Standard C-105/A21.5-05, Polyethylene Encasement for Ductile Iron Pressure Pipe and Fittings. The raw materials used to manufacture polyethylene film shall be Type 1, Class A, Grade E-1 in accordance with ASTM Standard Designations D-1250.

3.61.03 Extruded Polystyrene Insulating Foam

"Extruded Polystyrene Insulating Foam" or "Rigid, Cellular Polystyrene Thermal Insulation" also referred to as "XPS" shall be manufactured in accordance with ASTM C 578-08b. Bonding sheets of "XPS" together shall be accomplished by using "3M 78 Polystyrene Foam Insulation Spray Adhesive" or CITY approved equal.

3.62.00 CATHODIC PROTECTION

3.62.01 General

Unless otherwise specified, all materials and equipment shall be of the best quality used for the purpose in commercial practice. All materials and equipment shall conform to these STANDARDS AND SPECIFICATIONS.

3.62.02 Sacrificial Anodes

Dimensions of the magnesium anodes shall conform to the dimensions for standard sizes of anodes and of the weights specified. All magnesium anodes shall be cast around a galvanized steel core (flat strap or spring) and be made of high potential magnesium alloy conforming to the following compositions by weight:

	Aluminum	0.01% Max.
	Manganese	0.50% Min. to 1.30% Max.
	Zinc	0.005% Max.
	Copper	0.02% Max.
	Nickel	0.001% Max.
	Iron	0.03% Max.
	Other Impurities	0.05% Each Max.
	Other Impurities	0.30% Total Max.
	Magnesium	Balance

CONTRACTOR shall furnish spectrographic analyses or a letter of compliance on samples from each heat or batch of anodes used on the project.

Sacrificial anodes shall be provided with specific backfill in a permeable cloth sack. Anodes shall be centered in the backfill material and shall be buried to a depth as specified by the DEVELOPER. The weight and nominal dimensions of the packaged anode shall be as follows:

48 lb. bare anode (5.50" X 5" X 31") = approx. 100 lb. packaged (8" Dia. X 38"L)

The anode backfill material shall consist of 75 percent gypsum, 20 percent bentonite, and 5 percent sodium sulfate, and shall be of the quick wetting type.

All anodes shall be shipped and stored in waterproof bags or wrapping and shall be AMAX "MaxMag", Dow "Galvomag" or CITY approved equal.

Sacrificial anode lead wires shall consist of #12 AWG Type RHW or USE, black insulated stranded copper wire. Lead wires shall be a minimum of 25 feet in length. The lead wires shall be connected to the galvanized steel core of the anode by silver soldering and this connection shall be sealed with a waterproof epoxy or electrical potting compound.

3.62.03 Wire Conductors

Test station wires shall be #12 AWG and #8 AWG single conductor, stranded copper Type RHW. Wire color coding shall be as shown on the construction drawings.

Joint bond wires shall be #4 AWG single conductors, stranded copper with Type HMWPE insulation.

3.62.04 Wire Splice Connections

All splices of buried test station or anode wires shall be made using a mechanical connector and soldered then sealed with an epoxy type material. Splice kits shall be Royston "MINI SPLICE- RIGHT" with a "Crimpit" type or CITY approved equal.

3.62.05 Exothermic Welds

All electrical cable connections to the buried piping shall be made by an exothermic weld. Exothermic type weld materials including the proper size and type of weld cartridges and welder molds for use on steel or ductile iron pipe shall be by Erico Products Inc. "CADWELD" or Burndy "THERMOWELD" or CITY approved equal.

Copper sleeves specifically designed for the purpose shall be crimped on all bare wire ends of all stranded cables prior to exothermic welding to improve mechanical strength and thermal capacity.

3.62.06 Exothermic Weld Coating

For ductile iron pipe, exothermic weld coatings shall be a cold applied compound such as Koppers "Bitumastic 50", Royston "Roskote A51", or CITY approved equal.

For steel pipe, exothermic weld coatings shall be a mastic filled plastic weld cap such as Royston "Handicap" or CITY approved equal.

3.62.07 Test Stations

Flush mount cathodic protection test stations shall be those made specifically for the purpose and shall consist of test station enclosure, cast iron lid, terminal block with studs, and shunt.

Test station enclosures in shall be composed of concrete and shall be Brooks Products Inc.Model" No. 1-RT" or Christy Mfg. Model "G3" or "G5" with the lid inscribed with the words "CP TEST". Test station enclosures within vehicle traffic areas shall be cast iron in accordance with Section 3.54.04 of these STANDARDS AND SPECIFICATIONS.

A separate terminal board manufactured from a minimum 3/16 inch thick plastic or glass reinforced laminate with minimum dimensions of 3 inches by 4 inches shall be provided to terminate the test station and anode wires. Terminal boards shall be CP Test Services Model NM-5 terminal board or CITY approved equal.

Terminal board hardware shall be nickel plated brass and consist of a minimum of five 1/4 inch studs with double nuts, flat washers, and lock washers. The layout of the hardware shall be as shown on the CITY construction drawings.

Each test station shall also be furnished with a Colt Mfg. Co. calibrated 0.01 ohm - 8 ampere color code yellow) test station shunt or CITY approved equal. Exception: the shunt is not required at test stations designated as insulating fitting or test stations with no anodes type test stations.

3.62.08 Insulating Flange Kits

Dielectric flange kit materials shall consist of full faced gaskets, bolt sleeves, non-metallic washers, and steel backing washers.

Gaskets shall be “Type E”) (full face) phenolic with a Buna-N o-ring type sealing element**.**

Insulating bolt sleeves shall be the single one-piece sleeve and washer type made of Minion or acetyl resin plastic, shall fit within the bolt facing of the flange, and shall allow the standard size bolt or stud for the flange to be inserted. This subparagraph shall also apply to harness rods or tie bolts where insulating sleeves and washers are specified.

The steel backing washers shall be 1/8" thick; cadmium plated, hot rolled steel and shall fitwithin the bolt facing on the flange.

3.63.00 METERS

3.63.01 General

All water meters and transmitters shall be approved by the Utilities Department. Approval of the meter by size, type and brand shall be obtained from the CITY Meter Shop prior to purchasing the meter. All meters, other than residential 5/8” x ¾”, shall be purchased by the CONTRACTOR and delivered to the CITY Meter Shop to be pre-tested prior to installing the meter in the meter setting in accordance with Section 3.39.00 of these STANDARDS AND SPECIFICATIONS.

3.63.02 Magnetic Drive Positive Displacement-Type Water Meters

All magnetic drive displacement-type meters and displacement Type Bronze Main Case, and cold Water Meters Displacement Type Plastic Main Case shall conform to AWWA standards.

3.63.03 Compound and Turbine Meters

Compound meters shall conform to AWWA 702 current standard, Cold Water Meters Compound Type, and AWWA 701 current standard , Cold Water Meters Turbine Type, and C703 current standard (reaffirmed 2004) Cold Water Meters Fire Service Type. Strainers shall be provided upstream of all compound meters. Turbine meters shall be supplied with integral strainers.

3.63.04 Mastered Meters

Every "Master Metered" system to which fire hydrants or fire protection lines will be connected shall have a UL/FM approved "Fire Service Protection Water Meter" in accordance with AWWA C703 current standard (R04), Cold Water Meters – Fire Service Type. Public Works and Utility Department shall be contacted prior to design for meter requirements.

3.63.05 Meter Bypass Line

Bypass lines shall be required on all 1-1/2" and larger domestic water meter installations and shall contain an independent control valve. The bypass shall not contain tees, plugs, or other outlets through which water could be withdrawn. Bypass valves shall have locking devices.

3.63.06 Meter Check Valves

For 1-1/2" and 2" meter installations, single check valves shall be installed inline with the service pipe and downstream of the meter setter in accordance with the standard details of this chapter. Single check valves shall be manufactured in accordance with AWWA C800 current standard, Underground Service Line Valves and Fittings, and castings shall be constructed of brass in accordance with ASTM-B62.

Single check valves for 1-1/2" and 2" meter installations shall be the following type or equal as approved in writing by the CITY ENGINEER:

Ford HS11-666 (1-1/2"); HS11-777 (2")

For 3" and larger meter installations, swing check valves shall be installed downstream and adjacent to the meter as well as on the bypass. Swing-check valves shall be manufactured in accordance with AWWA Standard C-508 current standard, Swing-Check Valves for Waterworks Service (2 in through 24 in) and shall have interior epoxy coating in accordance with AWWA Standard C-550 current standard, Protective Interior Coatings for Valves and Hydrants. Swing check valves shall have an outside lever and weight and shall have

metal seats. Swing check valves shall be iron body bronze mounted with flanged ends in accordance with ANSI B16.1.

Swing check valves for 3" and larger meter installations shall be the following type or CITY approved equal:

American Flow Control, Series 52-SC and 600
AVK, 41 Series
Mueller, A-2600-6-01
Kennedy, Style 1106

3.63.07 Meter Valves

Meter valves for ¾" through 2" services shall be manufactured in conjunction with the setter. Valve shall be an angle lock wing type ball valve and shall be on the inlet side of the setter for ¾" and 1" setters and on the inlet and outlet sides for 1-1/2" and 2" setters.

For valves 4" and larger, gate valves shall be used and shall conform to Section 3.54.02 of these STANDARDS AND SPECIFICATIONS.

3.63.08 Meter Yokes (Setters)

All meter setters shall be manufactured in accordance with AWWA C800 current standard, underground Service Line Valves and Fittings, and all castings shall be constructed of brass in accordance with ASTM-B62. Meter setters shall be designed in accordance with the detail drawings in the appendix of this chapter.

The following meter setters shall be the following type or CITY approved equal:

	¾"*	1**	1½"***	2"***
McDonald	732-3-09WX2233	732-4-WX2244	720B618WWFF665	720B718WWFF775
Ford	VB83-9W-44-33-G	VB84-10W-44-44-G	VBB76-18-11-66-G	VBB77-18-11-77-G
Mueller	B-2474N	B-2474N	B-2474N	B-2474N

* 9" setter height

** 10" setter height.

*** 12" setter height. Requires bypass piping.

The following irrigation meter setters shall be the following type or CITY approved equal:

AY McDonald	731-3 - - WDTT 33 731-4 - - WDTT 44
Ford	VBHC83W-22-33-NL
Mueller	B-2474-2AN

Bypass orientation will not be allowed on a meter setter solely dedicated for irrigation use.

For installation of a smaller meter on an existing setter, size changes shall be accomplished by providing a full sized meter vault and setter for the line size

installed and using industry standard adapters to install a reduced size meter in the full size line. Adapters: shall be the following type or CITY approved equal:

1 ½" meter on 2" line	- 1 pair Ford A67 adapters
1" meter on 2" line	- 1 pair Ford A47 adapters
1" meter on 1 ½" line	- 1 pair Ford A46 adapters
5/8" X 3/4" meter on 1" line	- 1 pair Ford A24 adapters
3/4" meter on 1" line	- 1 pair Ford A34 adapters
Other sizes	- Contact Utilities/Meter Shop

3.63.09 Valve and Meter Supports

Meter supports shall be fabricated of concrete and valve supports shall be fabricated of steel in conformance with detail W13 of these STANDARDS AND SPECIFICATIONS.

3.63.10 Meter Pits (3/4" and 1" service lines)

Meter pits for ¾" and 1" service lines shall be constructed of modified high density polyethylene with a minimum nominal wall thickness of 0.50", shall have protective UV degradation with a low temperature brittleness which exceeds -76°F, a thermal transfer rate of .40, smooth walled (inside and out) and shall have a vertical crush rating which exceeds 20,000 pounds. No meter pits shall be set in streets, concrete areas, driveway alignments, or other areas of vehicle traffic.

Meter pits shall be the following type or CITY approved equal:

Mid-States Plastics Inc. B-Series, SIGMA-Raven or Carson Heavywall (20" dia. for ¾" services and 24" dia. for 1" residential and commercial services, and 30" dia. for 1" residential services with backflow required in meter pit)

A concrete meter pit is available as an alternate to the plastic meter pit upon approval in writing by the CITY ENGINEER. Note that this meter pit is not intended for installation in areas of vehicle traffic. Concrete meter pits: shall be the following type or CITY approved equal:

Copeland Enterprises, Inc., 24" & 30" Water Meter Pit.

Meter pit covers shall be airtight and shall have a cast iron recessed top lid and bonnet with a locking screw forged pentagon bolt. Lids shall have a 2" diameter hole centered in the lid for the transponder. A deep dish plastic inner lid shall be provided below the top lid. Meter risers shall not be allowed on new meter pit installations.

Meter pit covers shall be the following type or CITY approved equal:

Residential and commercial 5/8 x ¾" or 1" meter pits- AY McDonald CM70TPLIDCI , Ford W33HT, or Vestal #32-764

Residential 1" meter pits with backflow required- AY McDonald 74ML20HT

Commercial meter pits- refer to diagrams

3.64.00 PRESSURE-REDUCING VALVE

All pressure-reducing valves shall be approved by CITY ENGINEER. The valve shall be designed to reduce a high upstream pressure to a constant downstream pressure by way of a pilot control system. The pilot system shall control the main valve which shall be single-seated, hydraulically-operated, diaphragm, globe-valve type. The typical valve seats shall be bronze (Note that the manufacturer recommends stainless steel seats when subjected to sustained high velocities through the valve). An indicator rod or flow tube shall be furnished as an integral part of the valve to show the position of the valve.

3.65.00 COMBINATION AIR VALVES

Air release valves shall be in conformance with AWWA C512 current standard, Air Release, Air/Vacuum and Combination Air Valves.

Single body combination air valves shall be the following type or CITY approved equal:

Note that inflow preventers shall be required on all vault installations:

Val-Matic, Flood Safe

Combination air valves 2" and smaller shall have threaded NPT type inlets and outlets. For 3" and larger combination air valves, inlets shall be flanged.

3.66.00 RESTRAINING SYSTEMS

3.66.01 Harness Rods

Harness rods and nuts shall be SAE type 304 stainless steel

3.66.02 Joint Restraint Devices

Joint restraint devices shall be manufactured of ductile iron conforming to ASTM A 536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to AWWA C111/A21.11-07, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings, and ANSI/AWWA C153/A21.53-06, Ductile Iron Compact Fittings. Twist-off nuts, sized the same as the tee-head bolts, shall be used to insure that the proper torque is applied to the bolts. In no case shall the twist-off bolts be torqued beyond the manufacturers' recommendations.

Mechanical joint restraint device shall have a working pressure of at least 350 psi for pipe sizes 4-16 inch and 250 psi for pipe sizes 18-48 inches, with a

minimum safety factor of 2:1. Mechanical joint restraint devices shall be the following type or CITY approved equal:

EBAA Iron, Mega-lug, Series 1100 (DIP), Series 2000 (PVC)
Star, Series 3000, 3000S and 3000OS (DIP), Series 4000 (PVC)
Uniflange, Series 1400

Push on joint bell restraint harnesses shall have working pressures for PVC pipe of at least 200 psi for sizes 12 inches and smaller, 235 psi for pipe sizes 14 to 16 inches and working pressures for ductile iron pipe of at least 350 psi for pipe sizes up to 16 inches. Bell restraint harnesses shall be the following type or CITY approved equal: (bell restraint harnesses are not recommended for pipe sizes above 16 inches):

EBAA Iron, Mega-lug, Series 1700 (DIP), Series 1500, 1600 and 2800 (PVC)
Star Pipe Products, Series 3100P (for DIP only)
Smith-Blair, Series 165 (for PVC only)

3.67.00 CONCRETE REINFORCEMENT

All deformed reinforcing bars shall conform to ASTM Standards A-615, Grade 40 or 60, or ASTM Standard A-671, Grade 40 or 60. All welded wire steel fabric shall conform to ASTM Standard A-185.

3.68.00 BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assemblies shall conform to the requirements of AWWA C510 current standard, Double Check Valve Backflow Prevention Assembly, and C511 current standard, Reduced Pressure Principle Backflow Prevention Assembly. Backflow assemblies shall also meet the application requirements in Section 3.24.08 of these STANDARDS AND SPECIFICATIONS and Section 8-7-27 of CITY CODE.

3.69.00 REPAIR CLAMPS

Repair clamps shall be entirely 18-8 Type 304 stainless steel including bands, lugs, nuts, and bolts. Gaskets shall be gridded virgin GPR compounded for water service and meeting the requirements of ASTM D 2000-90M 4AA607. Repair clamps shall be single or double panel as required to fit the pipe and shall have a minimum working pressure rating of 150 psi. Repair clamp length shall be greater than or equal to the host pipe diameter.

Repair clamps approved by the CITY shall be one of the following types:

PowerSeal, Model 3121AS or 3122AS
Ford, Style FS1 or FS2
Smith-Blair, Models 261 and 262
Romac, XR-501, Style SS1 or SS2

TABLE OF CONTENTS

CHAPTER 4
SANITARY SEWER SYSTEM

Page

4.00.00 INTRODUCTION 4-1

4.01.00 USE OF SANITARY SEWER 4-1

4.10.00 DESIGN CRITERIA 4-1

4.11.00 SCOPE 4-1
4.12.00 GENERAL 4-2
4.12.01 Utility Studies 4-2
4.12.02 Study Requirements 4-3
4.13.00 DESIGN FLOW 4-5
4.14.00 HYDRAULIC SIZING OF SEWER LINES 4-6
4.14.01 General 4-6
4.14.02 Sanitary Sewer Mains 4-6
4.14.03 Sanitary Sewer Service Lines 4-7
4.15.00 SYSTEM LAYOUT 4-7
4.15.01 General 4-7
4.15.02 Waterline Crossing Over Sanitary Sewer Line 4-8
4.15.03 Sanitary Sewer Line Crossing Over Waterline 4-9
4.15.04 Storm Sewer Line Crossing Over Sanitary Sewer Line 4-9
4.15.05 Sanitary Sewer Line Crossing Over Storm Sewer Line 4-9
4.15.06 Limits on Vertical Separation 4-10
4.15.07 Sanitary Sewer Line in Alleys 4-10
4.16.00 EASEMENTS 4-10
4.17.00 FUTURE CONNECTIONS 4-11
4.18.00 SERVICES 4-11
4.18.01 Location and Alignment 4-11
4.18.02 Residential Service 4-12
4.18.03 Non-Residential Service 4-12
4.19.00 SERVICE TAPS 4-12
4.20.00 UNLAWFUL CONNECTIONS 4-12
4.21.00 SANITARY SEWER PRE-TREATMENT 4-12
4.21.01 Sewer Monitoring Manhole 4-12
4.21.02 Grease Interceptors General 4-13
4.21.03 Grease Interceptors Sizing 4-14
4.21.04 Sand/Oil Interceptors General 4-15
4.21.05 Sand/Oil Interceptor Sizing 4-15
4.21.06 Sand/Oil Interceptor Design 4-15
4.21.07 Abandoning FOGG Devices 4-16
4.22.00 APPURTENANCES 4-16
4.22.01 Manholes 4-16
4.22.02 Drop Manholes 4-17
4.22.03 Underdrains 4-18

4.30.00 CONSTRUCTION SPECIFICATIONS 4-18

4.31.00 EXCAVATION AND TRENCHING 4-18

4.32.00 BEDDING 4-18
4.32.01 General *4-18*
4.32.02 Granular Bedding *4-18*
4.33.00 PIPELINE INSTALLATION 4-19
4.33.01 General *4-19*
4.33.02 Pipe *4-19*
4.33.03 Steel Casing for Bores *4-20*
4.34.00 MANHOLE CONSTRUCTION 4-20
4.34.01 Cast-in-Place Base *4-20*
4.34.02 Pre-Cast Base *4-21*
4.34.03 Pre-Cast Barrel *4-22*
4.34.04 Manhole Grouting Treatment *4-22*
4.34.05 Adjustment Rings *4-22*
4.35.00 CONNECTIONS TO EXISTING MANHOLES 4-22
4.36.00 PRESSURE SEWERS 4-23
4.37.00 SANITARY SEWER SERVICE LINE CONSTRUCTION 4-23
4.38.00 TAPPING EXISTING SANITARY SEWERS 4-24
4.38.01 General *4-24*
4.38.02 PVC Pipe Tap *4-24*
4.38.03 Vitrified Clay or Cast Iron Pipe Taps *4-25*
4.38.04 Concrete Pipe Tap *4-25*
4.38.05 Tapping Lined Pipe *4-25*
4.39.00 TESTS 4-25
4.39.01 General *4-25*
4.39.02 Air Pressure Test of Pipe *4-26*
4.39.03 Deflection Test of Pipe *4-26*
4.39.04 Pressure Test for Pressure Sewers *4-27*
4.39.05 Manhole Vacuum Test *4-27*
4.39.06 TV Inspection of Sewers *4-28*
4.39.07 Pipe Cleaning Prior to Inspections *4-28*
4.40.00 ABANDONMENT 4-29
4.40.01 Pipes *4-29*
4.40.02 Manholes *4-29*
4.40.03 Services *4-30*
4.41.00 BYPASS PUMPING OPERATION 4-30

4.50.00 MATERIAL SPECIFICATIONS 4-31

4.51.00 GENERAL 4-31
4.52.00 DEFECTS 4-31
4.53.00 CERTIFICATION 4-31
4.54.00 PIPE 4-32
4.54.01 Polyvinyl Chloride Pipe (PVC) *4-32*
4.55.00 MANHOLES 4-32
4.55.01 General *4-32*
4.55.02 Manhole Rings and Covers *4-33*
4.55.03 Manhole Bases *4-34*
4.55.04 Joint Material *4-34*
4.55.05 Mortar *4-34*
4.55.06 Interior Coating *4-34*
4.55.07 Exterior Coating *4-35*

CHAPTER 4
SANITARY SEWER SYSTEM

4.00.00 INTRODUCTION

All sanitary sewer systems shall comply with the requirements of these STANDARDS AND SPECIFICATIONS and may include special criteria established by the CITY for overall hydraulics of the sanitary sewer system. Special criteria shall be outlined at pre-design meetings, as determined necessary by the CITY.

The DEVELOPER shall analyze any impacts to the existing off-site infrastructure. If there are any impacts, as determined by the CITY ENGINEER, additional analysis, such as hydraulic modeling, will be required at the DEVELOPER's expense. If off-site PUBLIC IMPROVEMENTS are required for the proposed development to be successful, the CITY and the DEVELOPER will negotiate the scope of the PUBLIC IMPROVEMENTS, any phasing, and payment by the DEVELOPER to the CITY for these off-site PUBLIC IMPROVEMENTS.

4.01.00 USE OF SANITARY SEWER

The use of sanitary sewers within the CITY of Westminster shall be in accordance with Title VIII, Chapter 8, of the CITY CODE.

4.10.00 DESIGN CRITERIA

4.11.00 SCOPE

It is the intent of this "design criteria" section to provide sufficient detailed information to enable the DEVELOPER to correctly and efficiently design the overall sanitary sewer system for a particular development. If there is a question or a concern regarding the design of any portion of the sanitary sewer system that is not adequately answered within this chapter, the DEVELOPER shall contact the CITY to get all issues resolved prior to design. Any deviation from these STANDARDS AND SPECIFICATIONS must be approved in writing by the CITY.

The Colorado Water Quality Control Act establishes the statutory framework for design approval of domestic wastewater treatment works (DWWTW) by the Water Quality Control Division. The statute, CRS 25-8-702, states "no person shall commence construction of any domestic wastewater treatment works or the enlargement of the capacity of an existing domestic wastewater treatment works, unless the site location and the design for the construction or expansion have been approved by the Division." DWWTW is defined as a system or facility for treating, neutralizing, stabilizing or disposing of domestic wastewater that has a designed capacity to receive 2,000 gallons per day or more and also includes appurtenances such as outfall sewers (24 inches and larger) and pumping stations and to equipment related to such appurtenances. All plans falling under this criteria shall be submitted to the State Water Quality Control Division for approval prior to construction.

4.12.00 GENERAL

The sanitary sewer system shall be designed by a Professional Engineer registered in the State of Colorado using the most current technical standards along with good, sound engineering judgment throughout the design process. The engineer shall have experience in the design and construction of municipal sanitary sewer systems. The development approval process includes the submittal of a Preliminary Development Plan, an Official Development Plan, utility studies and construction drawings for review and approval by the CITY.

All improvements to the sanitary sewer system shall be planned and designed to provide adequate service for a design horizon of 50 years unless a longer or shorter useful life period is stipulated or approved by the CITY. When approved by the CITY, proposed improvements may be phased over a period of time. For example, future phases of a subdivisions sanitary sewer system may not be constructed until service is required or when the land surface requires improvements.

The utility design process requires a study that falls into one of two categories outlined below. For small projects, such as a single residence that may have little impact on the nearby sanitary sewer system, a study may not be required. Prior approval is required by the CITY.

4.12.01 Utility Studies

A Utility Study may be submitted in various forms depending on the stage of the review process and projected goals for the development. A Master Utility Study may be required at a conceptual stage of a development project in order to assess the feasibility of providing sanitary service to a particular area or various alternates for providing such service and also confirms downstream sanitary pipe capacities. The Master Utility Study is based on CITY zoning requirements and possibly an Overall Development Plan but may not have detailed design flows for particular uses if they are not know at the concept stage in the design process.

A detailed Utility Study is required when specifics for a development project are known and may include flow projections for particular use types (refer to design criteria in sections 4.13.00 through 4.15.00 of these STANDARDS AND SPECIFICATIONS). The submission of a Master Utility Study is not a substitute for a Utility Study.

A Utility Conformance Letter shall be required for all lots or pad sites that are associated with a Master Utility Study. Utility Conformance Letters are an abbreviated report that confirms the site specific sanitary sewer flows for a project are below those projected in an approved Master Utility Study. Utility Conformance Letters shall also confirm there is available capaCITY in the sanitary sewer system downstream of the project based on current flow projections by the CITY in the basin.

4.12.02 Study Requirements

A Utility Study will be required for all projects or developments tributary to the CITY's sanitary sewer system and is required prior to approval of the Overall Development Plan, construction plans or issuance of a land disturbance permit. Analysis of the sanitary sewer can be combined with the analysis of the water system in the Utility Study. This study details the basis for the sewer design and provides the planning information necessary to assess the impact of a particular development on the CITY's sanitary sewer system based on anticipated sewer flows and available sewer pipe capacities.

At a minimum the study shall include the following information and shall be bound in an 8-1/2-inch x 11-inch folder and submitted to the CITY in both hard copy and .pdf electronic format:

A) Certification statement - shall be included at the beginning of the report and shall read as follows: "This Utility Study for the design of the _____ development was prepared by me or under my direct supervision in accordance with the City of Westminster's STANDARDS AND SPECIFICATIONS and acceptable professional practices of the industry. We acknowledge that the City of Westminster's review of this Utility Study is only for general conformance with submittal requirements, current design criteria and standard engineering principles and practices. We are also aware of the provisions of Section 11-6-5(B) of the Westminster Municipal Code of the City of Westminster." The seal and signature of the Professional Engineer responsible for preparing the report shall follow this statement.

(B) Report text, which addresses project location and description, project concept, discussion of any information that would affect the CITY's ability to serve the new area, and an analysis of the sanitary sewer system that includes the following at a minimum:

a) The area, in acres, which will be served by gravity with the new sewer and shown on a topographic map which delineates the basin boundaries as stated in (f) below.

b) The estimated population densities and total population based on land use projections to be served by the new sewer.

c) The estimated quantity and quality of any industrial wastes to be discharged to the system.

d) Open channel flow analysis using Manning's equation shall be performed for sewer mains 8 – 12 inches in size. Design flow rates, pipe capacities, flow velocities, pipe slopes, infiltration allowances and a detailed descriptions of all assumptions shall be provided in the report text such that all calculations can be verified.

e) Sewer mains 15 inches and larger shall be designed using standard industry software that profiles the hydraulic grade line along the pipeline alignment and analyzes head losses through all pipes and structures. A detailed description of the hydraulic analyses and assumptions shall be provided in the report text such that all calculations can be verified. A copy of the resulting hydraulic data shall be provided in an appendix of the report. Peak hydraulic grade lines shall be provided on design drawing profile views of the pipelines and structures.

f) The impact of projected flows from the project to a significant sewer outfall connection point downstream. The design engineer shall work with the CITY to establish the adequacy of the downstream sewer capacity based on the size of the proposed development, size of the outfall and capacities demonstrated in master planning studies that may be approved by the CITY.

g) Where projected flows for a project exceed those calculated in an approved master planning study from the CITY or if studies are not available, it will be the responsibility of the design engineer to demonstrate the impacts on the sewer system downstream of the project. A capacity analysis may be required at the developers' expense using the CITY wide hydraulic sewer model and CITY designated consultant familiar with development of the model. Flow monitoring may also be required for the analysis and at the developers' expense to determine available capacities in downstream sewers.

h) Report conclusions describing the results and how they follow the CITY criteria shall be provided. Any deviations from the CITY criteria shall be described and applicable variances requested.

(C) For construction plan submittals, design drawings shall include plan and profile figures with the following minimum information. Submittal of plan and profile drawings at the construction plan stage does not preclude the design engineer from verifying that sanitary sewer facilities are not in conflict with other facilities and utility corridors during earlier review stages.

a) Location of all proposed and existing easements and/or rights-of-way.

b) Existing and proposed utilities and appurtenances with sizes, slopes and horizontal and vertical locations.

c) Basin delineation and flow design points.

d) All other pertinent information that may pose a utility conflict.

(D) Appendices and Figures - Printed data output from any pipe flow analysis shall be provided in the Appendix and shall correspond with a figure of the pipe network. The Appendix shall also include hand calculations and any other pertinent data. A large size figure (24" x 36") illustrating the existing and proposed utility improvements may be required and should include building finished floor elevations, elevation contours and locations of proposed and existing utility easements and right-of-way as necessary.

4.13.00 DESIGN FLOW

Projected flows used to design the sanitary sewer system for a particular development vary depending on the type of development and land use. Six general categories of development for which typical average flow rates are given below include residential, restaurants, service, retail, office, hotel and industrial uses. For non-residential and non-hotel uses, apply the factor to the total area of the lot. Once the specific type of development is determined, peak design flows are calculated by multiplying the average flow with the peaking factor and then adding infiltration and inflow.

Typical Average Flow Uses:

Restaurants	1.24 Gallons/Minute/Acre*
Service	0.99 Gallons/Minute/Acre*
Retail	0.81 Gallons/Minute/Acre*
Office	0.40 Gallons/Minute/Acre*
Industrial	0.22 Gallons/Minute/Acre*
Hotel	5.16 Gallons/Minute/100 rooms*
R-36 residential zoning	0.07 Gallons/Minute/Unit*
R-18 residential zoning	0.07 Gallons/Minute/Unit*
R-8 residential zoning	0.09 Gallons/Minute/Unit*
R-3.5 residential zoning	0.10 Gallons/Minute/Unit*

Peaking Factor $3.6 \times [\text{Average Flow (mgd)}]^{-0.12}$, maximum value of 4**

Infiltration and Inflow 1000 Gallons/Acre/Day ***

Some development projects may not be considered "typical" as they may be infill type projects and capacities of the downstream sewer may be limited. In these cases, design flows must be calculated using historic flow data available from the CITY for various use types projected and available capacities in the downstream sewers may need to be modeled as described in section 4.12.02 (B) g. Refer to the "Orchard Town Center Sanitary Sewer System Analysis", February, 2013 by J&T.

Flow rates in pipelines downstream of lift stations shall take into account the maximum pumping rate generated by the pump station plus peak daily flow plus Infiltration and Inflow.

* From “Big Dry Creek Interceptor Sewer Improvements Preliminary Design” HDR, 2019.

** This equation was developed by the Metro Wastewater Reclamation District. This equation correlates well with the City’s interceptor system

*** From "1986 Sewer System Master Plan - City of Westminster," Brown and Caldwell.

4.14.00 HYDRAULIC SIZING OF SEWER LINES

4.14.01 General

Sanitary sewer shall be designed to carry the discharge calculated in this section and transport suspended material such that sediment is not deposited in the sewer.

The minimum diameter for sanitary sewer mains shall be 8-inches.

Oversizing of mains may be required by the CITY, and the recovery of the costs of such oversizing shall be in accordance with the Municipal Code.

The minimum diameter for sanitary sewer service lines shall be 4 inches.

4.14.02 Sanitary Sewer Mains

To achieve self-cleaning scour velocity and minimize odor and pipe degradation the “Tractive Force” design approach shall be used for all gravity sanitary sewer mains. Reference ASCE and WEF (WEF Manual of Practice No. FD-5 Gravity Sanitary Sewer Design and Construction, 2007, Section 5.6). This approach results in a self-cleansing minimum design slope associated with the design minimum flow rate (Q_{min}). Design pipe slopes and associated calculations shall be included in the Utility Study:

The following table gives the minimum and maximum allowable design slopes for sanitary sewer mains.

Table 4.14.01 Minimum and Maximum Sewer Main Slope

Pipe Diameter* (inches)	**Minimum Slope (%) (Use Greater of Two Values)**		**Maximum Slope (%)**
8	$0.0007760 \times (Q_{min})^{-0.56}$	0.50	19.0
10	$0.0008130 \times (Q_{min})^{-0.56}$	0.50	14.0
12	$0.0008460 \times (Q_{min})^{-0.56}$	0.22	11.0
15	$0.0008870 \times (Q_{min})^{-0.56}$	0.15	8.2
18	$0.0009221 \times (Q_{min})^{-0.56}$	0.12	6.4

21	As approved by the CITY

* Note that the design of sewers greater than 15 inch requires special attention. Slopes shown are intended for general guidance.

Sewers must be designed at slopes great enough to produce a minimum flow velocity of two feet per second (2 fps) at the peak flow rate. Sewers must also be designed at slopes that produce maximum flow velocities less than eight feet per second (8 fps) at the peak flow rate. Open channel flow (non-submerged) conditions must apply and use Manning equation with n = 0.013 for PVC pipe. Note that sewer pipes near dead ends typically require a greater minimum slope due to limited peak flows in these segments and must be designed accordingly.

The maximum design depth of flow to pipe diameter ratio for build-out peak flow (including I & I) shall be as follows (from URS, 2007):

d/D = 0.60 Pipe diameters 12 inch and smaller.
d/D = 0.80 Pipe diameters 15 inch and greater.

The design of pressure sanitary sewers is not covered in these specifications. Design, review and approval of this infrastructure shall be performed on a case-by-case basis.

4.14.03 Sanitary Sewer Service Lines

The following table shows the minimum and maximum allowable slopes for sanitary sewer service lines.

TABLE 4.14.03 Minimum and Maximum Sanitary Sewer Service Slope

Pipe Diameter* (inches)	Minimum Slope (%)	Maximum Slope (%)
4	2.08	8.0
6	1.04	6.0

4.15.00 SYSTEM LAYOUT

4.15.01 General

All mains shall be installed in dedicated rights-of-way or public easements. Public sanitary sewer mains shall not be installed parallel to and directly below any concrete such as sidewalks, curbs or gutters, unless approved otherwise by the CITY in writing. Where parallel to concrete such as sidewalks, curbs, and gutters, the centerline of the sanitary sewer shall be placed a minimum of 10 feet horizontally from the edge of the concrete.

Sanitary sewer mains shall be straight between manholes, both in horizontal and vertical alignment. Sewer mains will terminate in a manhole.

Sewer mains will typically have a minimum of eight feet of cover to finished ground surface. Where less than ten feet of elevation difference results between residential building finished floors and the extended sewer service invert, plans will indicate that the lot is served by a "shallow sewer" and appropriate elevation information will be given.

Sewer mains shall have a maximum cover of no more than 15 feet, unless approved otherwise in writing by the PWU.

Sanitary sewer mains shall be laid a minimum of ten feet horizontally from any existing or proposed utility, measured from outside edge of pipe to outside edge of pipe. Upon written approval by the CITY, a sanitary sewer main may be laid closer than ten feet to a parallel water main if it is laid in a separate trench and if the elevation of the invert of the water main is at least 18 inches above the crown of the sewer main, and in addition polyvinyl chloride pressure pipe is used for the sewer main.

When the sanitary sewer main passes under a highway, railroad or drainage or irrigation ditch, there shall be a minimum of 3-1/2 feet of cover and steel casing shall be installed in accordance with the detail drawings in the Appendix of this chapter. The steel casing shall extend the entire width of the right-of-way or easement of the crossing structure or as directed by the CITY. A cathodic protection system shall be designed for the casing pipe.

All-weather access shall be provided to all sanitary sewer manholes or other sewer appurtenances. All-weather access is defined as a paved road, concrete path, or crushed rock surface with depth capable of supporting maintenance machinery weighing up to 10 tons.

Public sewers may not be placed behind fences unless approved otherwise by the CITY. Any such fence approved by the CITY shall have gates that are accessible by utility maintenance staff at any time.

Sewer manholes shall be located such that storm water will not pond or infiltrate into manhole lids. Sewers shall not be placed within detention or retention ponds.

4.15.02 Water Line Crossing Over Sanitary Sewer Line

When there is less than 18 inches of vertical clearance between the water main and the sanitary sewer pipe, or water main pipe joints extend less than 10 feet each side of the sewer pipe, one of the following secondary containments shall be required for the water or sewer pipe:

1. Utilize Pressure Pipe AWWA C900.

2. Concrete or flowable fill encasement extending to any joints within 10 feet of the crossing.

Note that if joint-less pipe, such as fusible PVC or welded steel, is used for the water or sanitary sewer pipe then secondary containment will not be required. However, structural support of the water or sewer main using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

Minimum criteria is presented in this section, and applies to both public mains and private service lines.

4.15.03 Sanitary Sewer Line Crossing Over Water Line

When there is less than 18 inches of vertical clearance between the water main and the sanitary sewer pipe, or water main pipe joints extend less than 10 feet each side of the sewer pipe, one of the following secondary containments shall be required for the water or sewer pipe:

1. Utilize Pressure Pipe AWWA C900.

2. Concrete or flowable fill encasement extending to any joints within 10 feet of the crossing.

Note that if joint-less pipe, such as fusible PVC or welded steel, is used for the water or sanitary sewer pipe then secondary containment will not be required. However, structural support of the water or sewer main using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

Minimum criteria is presented in this section, and applies to both public mains and private service lines.

4.15.04 Storm Sewer Line Crossing Over Sanitary Sewer Line

When there is less than 18 inches of vertical clearance between the sanitary sewer line and the storm sewer line, the sanitary sewer line shall be encased in concrete a minimum of nine feet on each side of the centerline of the crossing, or PVC pressure pipe (AWWA C900) may be used for the sanitary sewer pipe. However, structural support of the sanitary or storm sewer using flowable fill main may be required to prevent settlement and permit maintenance of both utilities.

4.15.05 Sanitary Sewer Line Crossing Over Storm Sewer Line

When there is less than 18 inches of vertical clearance between the sanitary sewer line and the storm sewer line, the sanitary sewer line shall be encased in concrete a minimum of nine feet on each side of the centerline of the crossing, or PVC pressure pipe (AWWA C900) may be used for the sanitary sewer pipe. However, structural support of the sanitary or storm sewer main

using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

4.15.06 Limits on Vertical Separation

Under no circumstances shall the vertical clearance between any lines involving a waterline, sanitary sewer line, or storm sewer be less than 12 inches without prior written approval from the CITY.

4.15.07 Sanitary Sewer Lines in Alleys

The construction of sanitary sewer lines and fittings are not allowed in private alleys. The CITY ENGINEER shall consider the following criteria when reviewing requests for sanitary sewer installation in alleys:

1. There are unique physical circumstances or conditions, such as irregularity in size and shape of property to be developed, exceptional topographical, or other physical conditions peculiar to the affected property.
2. Special conditions and circumstances do not result from the present or prior actions of the applicant
3. Reduction of planned lots or other financial-related circumstances shall not be considered in this evaluation

See Standard Detail R4 for additional information.

4.16.00 EASEMENTS

All sanitary sewer mains shall be in an easement which has a width of at least two times the depth to the pipe invert. The minimum easement shall be 20 feet in width for one utility, 30 feet in width for two utilities and 40 feet in width for three utilities. Site-specific circumstances may dictate the need for wider easements. The main shall be located a minimum of ten feet from and parallel to the edge of the easement and shall be centered within the dedicated easement area. All easements shall be for the exclusive use of the CITY.

Restrictions on above-grade uses include most landscaping and permanent structures. If approved by the CITY grasses, annuals, perennials, and shrubs less than 24 inches will be allowed in utility easements. Trees and permanent structures (i.e., fences, mailboxes, sheds, buildings, etc.) are prohibited within utility easements.

Private utilities are prohibited within the easement with the exception of service lines from the main to the edge of the easement. Private storm sewers may cross CITY utilities within the easement in a perpendicular alignment, however storm sewer structures are prohibited within the utility easement.

The easement agreement shall state that any structures placed in the easement shall be removed by the owner of the land when requested by the CITY so that

maintenance can be performed. The owner of the land shall agree to hold the CITY harmless for any replacement of structures removed from the easement. The following statement shall appear on all Official Development Plans and all Final Plats:

"All public water, storm sewer and sanitary sewer mains and appurtenances located in public right-of-way shall be maintained by the City of Westminster Public Works Department. All public water, storm sewer, sanitary sewer mains and appurtenances located outside of public right-of-way shall be located in utility easements. City is responsible for maintenance of these water, storm and sanitary sewer facilities. City is not responsible for repair or replacement of private drive, curb and gutter or landscaping damaged during utility repair or maintenance."

4.17.00 FUTURE CONNECTIONS

Manholes shall have pipes stubbed out which are sized to accommodate flows from the upstream basin whenever a future extension of the sanitary sewer main is anticipated. The main line stub-out shall be capped and sealed.

4.18.00 SERVICES

4.18.01 Location and Alignment

Sanitary sewer service lines are private and shall be constructed on the shortest and straightest route possible from the sewer main to the building being served. At no time shall service lines be closer than 5 feet to the side property line, and no service line may be constructed through or in front of an adjoining property. Typically, the service line shall be located five feet toward the low side of the lot from the centerline of the lot and at least ten feet horizontally from a water service or water main. Each structure shall be served by a separate service line.

Six inch and larger sewer services shall require connection to sewer mains with a manhole. Any sewer services tying into sewer mains larger than fifteen inch shall also be made in a manhole.

The CITY shall not be responsible for locating sewer service lateral stub-outs for future connections.

Design of sewer services shall follow the criteria of the International Plumbing Code, as required by the CITY's Building Division. As such, two-way cleanouts may be required at all bends and every 100 feet minimum along the pipeline. Cleanouts are also recommended on all sewer services exterior to buildings.

4.18.02 Residential Service

Each unit with a CITY water meter is required to have a separate sewer service line. For multi-family housing such as townhome units, individual private sewer service lines may connect to a Home Owner Association (HOA) owned private sewer service and the HOA shall be responsible for the maintenance, repair, and replacement of these services. With the exception of HOA maintained lots, individual services shall not cross other privately owned lots.

4.18.03 Non-Residential Service

Each privately owned lot shall have a separate service line. For multiple tenants or units of a building on a common lot, individual private sewer service lines may connect to a building owner maintained private sewer service and the building owner shall be responsible for the maintenance, repair, and replacement of these services. With the exception of building owner maintained common lot, sewer services shall not cross other privately owned lots.

4.19.00 SERVICE TAPS

All four inch diameter sewer service connections to the sanitary sewer main shall be made using "wye" fittings, unless otherwise approved by the CITY.

When the diameter of the sewer service is six inches or larger, a manhole shall be constructed at the sewer main in place of a wye fitting. A sewer service tying into a manhole must be a minimum of six inches in diameter. Sewer service four inches in diameter are not allowed to discharge into public manholes. Benches shall be constructed in manholes to accommodate sewer service flow such that the flow transitions smoothly into the flow of the main.

Concrete sewer mains shall not be tapped for sewer services. A manhole shall be constructed at the concrete sewer main in place of a wye fitting and a six inch or larger service line will be required.

4.20.00 UNLAWFUL CONNECTIONS

It shall be unlawful to discharge roof drainage, foundation drainage, sump pumps, surface drainage, underdrains, RV dump sites or any other non-acceptable wastes to the sanitary sewer which would violate any of the provisions of Section 8-8-4 of the CITY CODE.

4.21.00 SANITARY SEWER PRE-TREATMENT

4.21.01 Sewer Monitoring Manhole

Any new building to be constructed in an industrially-zoned area with a floor space greater than five thousand square feet, or with a water meter size greater than three-quarter inch, or if otherwise required by the CITY, shall install a sewer-monitoring manhole prior to final building inspection approval. The monitoring manhole shall be situated outside of the building on the user's premises. If the industrial user's service line ties into an existing CITY manhole and such manhole allows for safe sampling and isolation of the industrial user's discharge, the CITY may allow said manhole to serve as the industrial user's monitoring facility.

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4.21.02 Grease Interceptors General

Gravity Grease Interceptor (GGI) are permitted by the CITY. GGI is defined as a large tank or retention device constructed to separate, trap, or hold fats, oil, grease, and grit (FOGG) substances from the sewage discharged from a facility in order to prevent their entry into the sanitary sewer collection system. GGIs are located outside of the building and must be readily accessible to outside inspections. CITY approved GGIs must be gravity flow without any flow control.

Hydromechanical Grease Interceptor (HGI) shall be prohibited in the CITY. HGI, also referred to as grease trap, is defined as a tank or retention device installed inside a building to separate, trap, or hold fats, oils, grease, and grit (FOGG) substances by flow control to prevent their entry into the sanitary sewer collection system. HGIs can also be found within the floor of the building with access hatches for maintenance purposes. The use of HGIs for new development, expansion, or redevelopment shall be prohibited by the CITY.

A GGI is required for all non-residential establishments where food or beverages will be processed, cooked, or prepared. Examples include, but are not limited to, businesses containing a commercial kitchen, restaurants, coffee shops, ice cream and frozen yogurt shops, smoothie shops, and commercial pet grooming facilities. An individual GGI shall be provided for each building, and in most cases, for each individual unit that meets the CITY's requirement criteria. In all cases, the determination of whether or not a GGI is required shall be reviewed and approved by the PWU as part of the building permit process.
All kitchen and/or food and beverage preparation waste lines shall be routed through an approved GGI prior to entering the public sewer system. Domestic waste from sanitary fixtures such as toilet and urinals shall not be allowed to enter the GGI. GGIs shall not serve more than one business establishment, unless specifically approved by PWU.

All GGIs shall be located outside the building on private property and as close as possible to the fixtures it serves. GGIs shall be readily accessible at all times for maintenance and inspection and shall not be placed in drive-through aisles or under trash cans / dumpsters. The use of ladders, unapproved placement, or the removal of equipment in order to service or inspect GGIs shall constitute a violation of accessibility, and can result in fees against the business. Accessibility is subject to review and approval by the PWU.

Venting for GGIs shall be located and designed such that odors emitted will not disturb nearby businesses or the public. Venting design is subject to review and approval by PWU.

4.21.03 Grease Interceptor Sizing

The permitted capacity of the GGI shall be determined by both the minimum allowable volume and the calculated volume based on fixture flow rates, whichever is greater. No individual GGI shall be less than 750 gallons in capacity. No shared GGI shall be less than 1,400 gallons in capacity.
All submittals must include the calculated capacity prior to approval by the PWU. See equation below for calculation guidelines.

The calculated volume of the GGI is based on the maximum flow rate into the GGI from plumbing fixtures in the kitchen and food preparation area as well as other fixtures that may receive FOGG-containing waste. The GGI capacity, in gallons, is calculated as the maximum flow rate of all fixtures discharging into the GGI multiplied by a detention factor of 8 minutes. Table 4.21.03 establishes the maximum flow rate, in gallons per minute (GPM), for various pieces of equipment and plumbing fixtures requiring connection to the GGI.

GGI Capacity (gallons) = 8 Minutes x Sum of Maximum Flow Rates (GPM)

Garbage Disposals: All garbage disposals shall discharge into a GGI. GGIs shall be sized for all plumbing fixtures plus the garbage disposal flow rate. Refer to Table 4.21.03 for the GPM rating to be added for each garbage disposal discharging into the GGI.

Table 4.21.03 Typical Flow Rate for Plumbing Fixtures

TYPE OF FIXTURE	TRAP & TRAP ARM SIZE	RATE OF FLOW (GPM)
Floor Drains:		
Discharging into interceptors for grease, oil, solids, etc.	2" 3”	15 20
Discharging into non-vehicle wash sand & oil interceptors	2” 3” or 4”	20 45
Discharging into vehicle wash sand & oil interceptors	3” or 4”	60
Sinks:		
Commercial bar sinks	1-1/2”	15
Restaurant kitchen sinks (single compartment)	1-1/2”	20
Restaurant kitchen sinks (three compartment)	1-1/2”	40
Restaurant hand sinks	1-1/2”	15
Service sinks (mop sinks)	2”	20

Dishwashers:		
Up to 50 gal. capacity	-	20
Over 50 gal. capacity	-	40
Garbage Disposals:		
Any size garbage disposal	-	35

4.21.04 Sand/Oil Interceptors General

To protect the wastewater collections system, sand/oil interceptors shall be installed on wastewater service lines serving facilities that may introduce sand, grit, metals, petroleum, and/or oil. This includes, but is not limited to, car wash facilities, automotive shops, machine shops and parking garages. Existing facilities that received approval from the City for waiving the requirement to install a sand/oil interceptor, or those that received approval of a sand/oil interceptor that does not meet current sizing standards, may be required to improve their system to meet current standards.

The owner and/or lessee shall be responsible for cleaning and maintenance of the sand/oil interceptor. It shall be completely cleaned when solids are within 8 inches of the bottom of the outlet tee. Maintenance records for the last three years shall be kept on site and made available to the Utilities Operations Division upon request.

4.21.05 Sand/Oil Interceptor Sizing

Sand/oil interceptors shall be sized per the following table, and have a minimum liquid capacity of 6 cubic feet or 45 gallons. They shall have two compartments, separated by a baffle wall.

Sand/Oil Interceptor Capacity (cubic feet) = Facility Service Area (square feet) ÷ Treatment Capacity factor from table

Type of Facility	Treatment Capacity per Cubic Foot of Sand/Oil Interceptor
Car Wash, Trucks or Heavy Equipment	15 Square Feet
Car Wash, Automatic Bay or Conveyor	50 Square Feet
Car Wash, Hand Held Spray	75 Square Feet
Automotive Shop or Machine Shop	100 Square Feet
Parking Garage	4,000 Square Feet

4.21.06 Sand/Oil Interceptor Design

Sand/oil interceptors shall be located outside of the building and be readily accessible for inspection, cleaning and maintenance.

Portions of car wash facilities that are exposed to precipitation shall not be connected to the wastewater collection system. Portions of car wash facilities that are covered and have floor drains shall be directed to a sand/oil interceptor. Car wash facilities without recycled water shall have floor drains directed to a sand/oil interceptor before connection to the wastewater main.

Car wash facilities with recycled water may have a sand/oil interceptor either upstream or downstream of the recycled water system, but must be installed before connection to the wastewater main. Hose bibs are not allowed on recycled water piping systems. Drinking water sources, playgrounds, eating areas and similar facilities shall be protected from recycled water use and over-spray. Signage indicating recycled water usage is required at the point of use to inform workers and the public. Recycled water pipes, valves, valve boxes, and fittings shall be properly color-coded and labeled "NOT POTABLE WATER – DO NOT DRINK" in English and any other dominant language that may be spoken at the site.

For automotive shops and machine shops, the sand/oil interceptor shall have a minimum depth of 2 feet below the invert of the outlet pipe and the outlet pipe shall have a minimum water seal of 18 inches.

Parking garages exposed to precipitation shall not have that portion connected to the wastewater collections system. This includes, but is not limited to, the roof of the parking garage and trench drains placed at the entrance and exit. Portions of a parking garage that are covered and have floor drains shall be directed to a sand/oil interceptor and then to the wastewater collections system.

4.21.07 Abandoning FOGG Devices

FOGG devices can only be abandoned with permission of PWU. FOGG devices that are approved to be abandoned in-place shall be cleaned of all grease, oil and debris. The inlet and outlet pipes shall be plugged at each end of the abandoned FOGG device and the device filled with sand, gravel, flash fill or flow fill. Access covers shall be sealed.

4.22.00 APPURTENANCES

4.22.01 Manholes

The maximum spacing between manholes shall be four hundred (400) feet. Manholes shall be located in areas that allow direct access by maintenance vehicles when it is not feasible to locate the manhole in the public street.

Manholes shall not be located in areas that are subject to flooding from surface runoff.

All manholes located outside of paved roadways shall be designed and constructed with a locking and hinged type cover in accordance with the details in the appendix of these STANDARDS AND SPECIFICATIONS.

To delineate the location of manholes in non-paved areas they shall be marked using a 3 foot tall steel marker post set in concrete, painted green and located within ten (10) feet of the manhole. Lettering shall be provided on the post to indicate the distance to the manhole and the lettering shall face the direction of the manhole (Example: SSMH-7').

Manholes constructed with 24 inch and larger sewer mains shall require 30 inch nominal diameter ring and cover assemblies. Manholes constructed with sewer mains smaller than 24 inch shall require 24 inch nominal diameter ring and cover assemblies, unless larger assemblies are required by the CITY for maintenance.

Chemical and gas resistant manhole interior linings shall be required on all newly constructed sewers fifteen inches and larger or other manholes downstream of a discharge source that are determined by the CITY to be at risk of deterioration. High levels of hydrogen sulfide gases (H_2S) and other corrosive discharges, such as from brewery's and downstream of sewer force mains, contribute to the degradation of manholes and warrant interior linings. The number of manholes requiring lining shall be evaluated by the CITY on a case-by-case basis.

Bituminous coatings shall be required on manhole exteriors on all newly constructed sewers in order to waterproof manholes and reduce infiltration.

4.22.02 Drop Manholes

Drop manholes will be required when a sewer main enters a manhole at an elevation greater than twenty-four inches above the manhole invert and must be approved in writing by the CITY. Drop manholes will only be allowed when the design engineer demonstrates that alternate vertical pipe alignments to reduce the vertical drop within the manhole and maintain acceptable pipe velocities is not feasible. No vertical invert drop within a manhole shall exceeded ten feet. Drop manholes shall be constructed in accordance with the detail drawings in the Appendix of this chapter.

Inside drop manholes shall be used on sewer mains twelve inches and smaller. Minimum manhole diameters shall be constructed in accordance with the detail drawings in the Appendix of this chapter for various sewer main sizes. A larger manhole than that specified in the details may be required in order to provide a smooth transition for drop flows converging at an angle with main pipe flows.

Outside drop manholes shall be used on sewer mains greater than 15 inches and shall be installed in accordance with the detail drawings in the Appendix of this chapter.

When connecting sewers with vertical drops of twenty-four inches or less, a smooth transition or "beaver slide" shall be constructed to reduce turbulence in the flow.

Sewer service connections shall not be made using an inside drop. Sewer services six inch and larger shall use an outside drop manhole and four inch services shall connect directly to the sewer mains.

4.22.03 Underdrains

Underdrains are privately owned infrastructure and are not a CITY-maintained utility. The DEVELOPER shall receive written approval from the CITY prior to installation of underdrains near CITY-maintained utilities. Under no circumstance shall the underdrain be connected to the sanitary sewer. Perforated underdrain pipe shall be white or black in color wrapped in geofabric and shall have a marker tape installed two feet above the pipe labeled "Underdrain."

4.30.00 CONSTRUCTION SPECIFICATIONS

4.31.00 EXCAVATION AND TRENCHING

Excavation, trenching and backfilling shall be done in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

4.32.00 BEDDING

4.32.01 General

In the event unstable trench conditions are found at pipeline grade, a minimum of one and one-half inch uniformly graded, washed rock shall be used for trench stabilization. Depth of stabilization shall be as approved by the CITY. Pipe bedding shall be done in accordance with Sections 4.32.02 of these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter.

4.32.02 Granular Bedding

Granular Bedding is defined as that method of bedding in which the pipe is set on granular material meeting the requirements of Chapter 9 of these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter. Bedding shall be placed to a depth below the bottom of the pipe equal to one-fourth of the outside pipe diameter but not less than four inches. In rock excavation this minimum depth shall be six inches. Bedding material shall be placed around the sides of the pipe and to a minimum of nine inches above the top of pipe.

4.33.00 PIPELINE INSTALLATION

4.33.01 General

The CITY shall be notified at least 48 hours in advance of any pipe installation. No pipes shall be backfilled until they have been inspected by the CITY. Alignment and grade of the pipe and the location of fittings, and manholes shall be staked under the supervision of a professional surveyor registered in the State of Colorado. When constructing sewers at or near the minimum design slope, survey confirmation should be performed on a daily basis so that pipelines installed incorrectly can be readily corrected prior to backfill. Refer to minimum design slope requirements in section 4.14.02 of this Chapter.

Proper implements, tools and facilities shall be provided and used by the CONTRACTOR for the safe and convenient execution of the work. All pipe fittings, and manhole sections shall be carefully lowered into the trench by means of a derrick, ropes or other suitable tools or equipment to prevent damage to sanitary sewer line material. Under no circumstances shall sanitary sewer line materials be dropped or dumped into the trench.

All pipe fittings shall be carefully examined for cracks and other defects immediately before installation. The groove in the bells of the pipe shall be full and continuous or the pipe will be rejected. Defective pipe or fittings shall be removed from the job site within 24 hours of notification by the CITY. All foreign matter or dirt shall be removed from the interior and ends of the pipe before they are lowered into position in the trench and prior to connection.

Every precaution shall be taken to prevent foreign material and trench water from entering the pipe and fittings. During construction, the CONTRACTOR shall provide and maintain adequate equipment to properly remove and dispose of all water entering the trench and any other part of the work.

4.33.02 Pipe

Pipe shall be laid from downstream to upstream with spigot ends pointing downstream. All pipe shall be placed true to line and grade and carefully centered and with a smooth invert at the joint. The joint shall be made in a workmanlike manner and shall be watertight. Immediately before joining two lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned. Caution shall be exercised to ensure that the correct type of gasket is used. A thin film of gasket lubricant shall be applied to the inside face of the gasket and the spigot end of the pipe. The spigot end of the pipe shall be placed in the bell with care to prevent the joint from contacting the ground. The joint shall be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements. Pipe furnished without a depth mark shall be marked before assembly to ensure insertion to the full depth of the joint. The pipe shall then be properly set and brought to correct line and grade. The pipe shall then be secured in place by installation of bedding material and backfill, in

accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS and the detail drawings in the Appendix of this Chapter.

At times when installation is not in progress, the open ends of the pipe shall be closed with a watertight plug. Cutting of pipe for inserting closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining, leaving a smooth end at right angles to the axis of the pipe. Pipe ends shall be smooth and beveled with a file or other tools according to the pipe manufacturer's recommendations.

Extra care should be used in handling PVC pipe during cold weather due to the reduced flexibility and impact resistance as temperatures approach and drop below freezing. PVC pipe to be stored outside and exposed to sunlight for more than 30 days shall be covered with an opaque material such as canvas. Clear plastic sheets shall not be used to cover the pipe. Air circulation shall be provided under the covering. Any over-exposed pipe, as determined by the CITY, will not be permitted for installation.

No pipe or appurtenant structure shall be installed upon a foundation in which frost has penetrated or at any time when the CITY deems there is a danger of ice formation or frost penetrations at the bottom of the excavation. No pipe or appurtenant structure shall be installed unless backfilling can be completed before the formation of ice and frost.

4.33.03 Steel Casing for Bores

Steel casing pipe for bores shall be seam welded and have an inside diameter of at least 2 to 3 pipe sizes greater than the outside diameter of the carrier pipe to accommodate casing spacers and joint restraints as required. Spiral welded casing shall not be allowed. The minimum wall thickness of the casing pipe shall be in accordance with the standard detail in the appendix of these STANDARDS AND SPECIFICATIONS.

Carrier pipe material shall be according to Chapter 3 of these STANDARDS AND SPECIFICATIONS. All carrier pipe joints shall be mechanically restrained inside the casing. Casing end seals shall be specified per design engineer recommendations and in accordance with the detail drawing in the Appendix of this chapter. Casing spacers shall be stainless steel with adjustable glass filled polymer runners in accordance with the detail drawings in the Appendix.

4.34.00 MANHOLE CONSTRUCTION

4.34.01 Cast-in-Place Base

Cast-in-place bases may be used for sewer connection to an existing pipe or as approved by the CITY. Typically pre-cast bases shall be installed for new construction. Manhole bases shall be constructed with concrete in conformance with these STANDARDS AND SPECIFICATOINS, placed on

undisturbed ground and in conformance with the detail drawing in the Appendix of this Chapter. Changes in direction of flow through the manhole shall be made with a smooth curved channel having as large a radius as possible. The change in size of channels shall be made gradually and evenly and shall be formed directly in the concrete. The floor of the manhole outside of the channel shall be finished to a brushed surface. Construction of cast in place manhole bases shall be of high quality workmanship.

Concrete bases shall extend at least eight inches below the invert of the pipe and shall be benched to at least two inches over the top of the pipe. The manhole floor between the sewer pipe and the outer portions of the bench shall be flush with the top edges at the pipe spring line and shall slope upward at least two inches per foot.

The shape of the invert shall conform to the lower half of the pipe it connects. Side branches shall be constructed with as large a radius of curvature as possible. Inverts shall be plastered with cement mortar and left smooth and clean. Where called for on the plans, a pipe bell shall be stubbed out and plugged. The bell shall be placed as close to the manhole wall as possible, unless showing otherwise on the approved plans.

Bases shall be reinforced with a grid of #4 rebar on 12 inch centers and bars aligned perpendicular. Reinforcement shall be approved by the CITY prior to installation.

4.34.02 Pre-Cast Base

Pre-cast bases will be allowed by the CITY and shall be in conformance with this section.

The ground surface below the precast concrete base shall be excavated six inches minimum below the elevation of the bottom of the base and backfilled with bedding in accordance with the detail in the appendix of these STANDARDS AND SPECIFICATIONS. The bedding shall be carefully leveled and smoothed to give uniform support to the precast base over its entire area. The precast base shall be set at the proper location to center the manhole over the sewer main.

Inverts shall be poured in bases after it has been set in place and pipes installed. Changes in direction of flow through the manhole shall be made with a smooth curved channel having as large a radius as possible. The change in size of channels shall be made gradually and evenly and shall be formed directly in the concrete. Benches in the manhole shall be brush finished.

The precast base shall also conform to the requirements of Section 4.55.03 of these STANDARDS AND SPECIFICATIONS.

4.34.03 Pre-Cast Barrel

Precast manhole sections shall not be placed on a cast in place base until it has reached sufficient strength to provide support without damage. The joint between the manhole base and barrel section shall be sealed with a flexible butyl resin joint compound.

4.34.04 Manhole Grouting Treatment

The inside horizontal joints between precast manhole sections shall be plastered and troweled smooth with cement mortar. The mortar shall be not less than five eighths inch in thickness over the joint and shall extend at least four inches on either side of the joint. Exterior horizontal joints shall be wrapped with ConWrap joint wrap, or approved equal, and secured to the concrete to provide a watertight seal.

All smooth surface pipes, such as PVC or VCP shall have a manhole water-stop gasket, to be furnished by the CONTRACTOR, firmly attached to the pipe prior to grouting into the manhole. The opening in the manhole wall where a pipe enters or leaves shall be sealed and patched in a neat workmanlike manner, both inside and out with cement mortar. All lifting holes and other imperfections in the interior manhole wall shall be filled with cement mortar.

4.34.05 Adjustment Rings

Precast concrete adjustment rings shall be used on top of the cone to support and adjust the manhole ring and cover to the required final grade. The maximum depth of the adjustment rings shall be twelve inches. If manholes are located in paved areas, the maximum depth from the top of cone to street grade shall be 18 inches and the ring and cover shall be left 1/8 inch below the pavement surface.

If manholes are located in field installations, the ring and cover shall be 12 to 18 inches above final grade. A locking ring and cover shall be provided in all field installations.

4.35.00 CONNECTIONS TO EXISTING MANHOLES

Sewer pipe connections to existing manholes where there is no existing pipe stubbed out shall be made in such a manner that the finished work will conform as nearly as practicable to the requirements specified for new manhole construction. The CONTRACTOR shall core drill a suitable opening in the existing manhole to insert the new sewer pipe. The existing concrete foundation bench shall be chipped to the cross-section of the new pipe in order to form a smooth continuous invert similar to what would be formed in a new concrete base. The downstream invert shall be plugged or otherwise protected during construction to prevent storm and non-sewage flow from entering the system. The CONTRACTOR shall pump out and clean the manhole before removing the plug. Rubber sealing gaskets shall be

installed to provide a water tight seal in accordance with the details in the appendix of these STANDARDS AND SPECIFICATIONS. Cement mortar shall be used to smoothly finish the pipe stub, both inside and outside of the manhole, and form the new invert.

4.36.00 PRESSURE SEWERS

At a minimum, all Chapter 3 requirements of these STANDARDS AND SPECIFICATIONS shall apply to the installation of pressure sanitary sewer lines. All pressure sanitary sewers shall be installed using PVC C-900 per AWWA, or as approved otherwise by the CITY.

Tracer wire shall be attached to the pipeline for future locating. A green plastic identification strip, a minimum of a six-inch wide, continuously labeled "Caution Sewer Line Below" shall be installed directly above the pressure sewer, the full length of the sewer, and shall be buried midway between the top of the pipe and the finished ground surface elevation.

4.37.00 SANITARY SEWER SERVICE LINE CONSTRUCTION

All sanitary sewer service lines which connect to the CITY sanitary sewer system shall comply with these STANDARDS AND SPECIFICATIONS. Sewer services shall be inspected prior to backfill by a CITY INSPECTOR and twenty-four (24) hour notice will be required prior to inspection.

The CONTRACTOR shall place wyes, stubs, and risers where required by the approved plans. Wyes shall be angled upwards so that the upper invert of a one-eighth bend connected to the fitting will have an elevation equal to or higher than the inside crown of the sewer main. Riser connections shall be installed where the elevation of the top of the branch is more than twelve feet below the approved finished grade. Riser connections will ordinarily reach to a grade ten feet below the finished ground surface. Water-tight plugs shall be installed in each branch pipe or stub. As-built measurements shall be made by the CONTRACTOR or his representative to reference the wye or riser connection to the nearest manhole before backfill. Said measurements shall be carefully and accurately made and recorded and shall be shown on the as-built plans furnished to the CITY prior to acceptance.

All installation work shall conform to applicable portions of ASTM C-12 and to the pipe manufacturer's installation instructions. The grooves shall be cleaned free of all foreign materials prior to assembling the joint. The pipe shall be laid with the spigot end pointing in the direction of the flow.

Trenches shall be kept free of water during laying and jointing. Lines shall be laid with a laser, or other means approved by the CITY.

Two-way cleanouts may be required at all bends and every 100 feet minimum along the pipeline as required by the International Plumbing Code. The area around a clean-out shall be graded so water runs away from the clean-out. No clean-outs shall be installed in publicly owned rights-of-way or easements unless approved by the CITY. Cleanouts installed on private property should be protected as to avoid damage to the cap and become a source for inflow and debris.

Service stub-ins shall be extended at a minimum to the edge of RIGHT-OF-WAY and be plugged with a glued cap.

Backfilling shall be in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

4.38.00 TAPPING EXISTING SANITARY SEWERS

4.38.01 General

Where service wyes were not installed in the sewer main during initial construction, a tapping saddle shall be installed and a hole shall be machine drilled in the main appropriately sized to fit the tapping saddle. The drilling machine, method of drilling and tapping saddle shall be approved by the CITY. The saddle shall provide a water tight seal when attached to the main and held in place with metal straps or other approved methods. The saddle and sewer main shall be encased in concrete a minimum of 6 inches in all directions. The tapping saddle or connection shall not protrude into the main or provide a means to catch debris.

Service taps shall have a minimum spacing along the main of 24 inches so that the strength of the pipe is not compromised, and taps shall be located a minimum of 24 inches from pipe joints.

The CITY INSPECTOR shall inspect the tap and the service line to the building before backfilling. Twenty-four hour notice is required prior to inspection. In the event the tap and service line are covered before it is inspected, it shall be re-excavated by the CONTRACTOR, and cleared allowing for visual inspection of the tap and main. If the sewer main is cracked or broken during the process of locating or tapping, it shall be repaired immediately by replacing the broken section at the CONTRACTOR’s expense.

4.38.02 PVC Pipe Tap

Where PVC service wyes have not been installed in the sewer main, a PVC tapping saddle shall be installed according to the manufacturer's recommendations and these STANDARDS AND SPECIFICATIONS. Edges of the tapped hole shall be filed smooth and the surfaces to be jointed shall be wiped clean, etched and the primer applied. With primer still wet, the approved cement shall be applied and saddle install. The saddle shall be drawn down with manufacturer provided stainless steel straps to the

specified torque. The saddle and sewer main shall be encased in concrete a minimum of 6 inches in all directions.

4.38.03 Vitrified Clay or Cast Iron Pipe Taps

Where service wyes have not been installed in the sewer main, a PVC tapping saddle shall be installed according to the manufacturer's recommendations and these STANDARDS AND SPECIFICATIONS. Edges of the tapped hole shall be smooth and the surfaces to be jointed shall be wiped clean. The saddle shall be drawn down with manufacturer provided stainless steel straps to the specified torque. The saddle and sewer main shall be encased in concrete.

4.38.04 Concrete Pipe Tap

Concrete mains shall not be tapped. A manhole according to these STANDARDS AND SPECIFICATIONS shall be installed to provide sewer service.

4.38.05 Tapping Lined Pipe

When a tap is made on a main that has been lined, the sewer host pipe shall be removed around the circumference of the service wye to provide clear access to the liner for securing the tapping saddle. A keyhole, saber saw or shell cutter shall be used to cut a round hole in the liner. Edges of the tapped hole shall be filed smooth and the surfaces to be jointed shall be wiped clean, etched and the primer applied. With primer still wet, the approved cement shall be applied and saddle install. The saddle shall be drawn down with manufacturer provided stainless steel straps to the specified torque. The saddle and sewer main shall be encased in concrete.

4.39.00 TESTS

4.39.01 General

All sanitary sewer mains and appurtenances shall be cleaned, tested and PACP TV inspected after backfill operations have been completed in accordance with these STANDARDS AND SPECIFICATIONS. Compaction test results shall be submitted to and approved by the CITY. If the completed line or any portion thereof fails any of these requirements, the CITY will not accept the work until it is properly corrected by the CONTRACTOR.

The CONTRACTOR shall furnish all labor, materials, tools and equipment necessary to clean the pipe and appurtenances, make the tests and perform all work incidental thereto. Any damages to the pipeline caused by cleaning or testing operations shall be repaired or replaced by the CONTRACTOR at his expense.

4.39.02 Air Pressure Test of Pipe

The CONTRACTOR shall perform these tests with suitable equipment specifically designed for air testing sewers. The line shall be plugged at each manhole with plugs or pneumatic balls. All service plugs shall be secured in place to prevent displacement during testing operations.

Low pressure air shall be introduced into the plugged pipe until the internal air pressure reaches 4.0 psi plus 0.4 psi per foot of water table above the pipe invert, if any. Pressure shall not increase above 9.0 psi. At least two minutes shall be allowed for the air temperatures to stabilize before readings are taken and the timing started.

Once the pressure has stabilized between 4.0 psi and 3.5 psi, timing shall commence to determine the amount of time for pressure to drop 0.5 psi. The test shall pass if the pipe pressure does not drop greater than 0.5 psi from the initial pressure reading within the time requirement listed in Table 4.41.01 below. Refer to Table II of Uni-bell's UNI-B-6-98 "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe" for additional pipe sizes and lengths.

Table 4.39.02 Minimum Time Requirement for Pipe Pressure Testing

Pipe Diameter (in)	**Time Requirement for Various Pipe Lengths (minutes:seconds)**						
	100 ft	**150 ft**	**200 ft**	**250 ft**	**300 ft**	**350 ft**	**400 ft**
8	3:47	3:47	3:47	3:47	3:48	4:26	5:04
10	4:43	4:43	4:43	4:57	5:56	6:55	7:54
12	5:40	5:40	5:42	7:08	8:33	9:58	11:24
15	7:05	7:05	8:54	11:08	13:21	15:35	17:48
18	8:30	9:37	12:49	16:01	19:14	22:26	25:38
21	9:55	13:05	17:27	21:49	26:11	30:32	34:54

If there has been no leakage after 50% of the time calculated of testing has passed, the test shall end and the section shall be accepted. If the installation fails this test, the testing equipment may be used to determine the location of the pipe leak.

4.39.03 Deflection Test of Pipe

The maximum vertical deflection allowed for PVC pipe is five percent. The CITY may require the CONTRACTOR to perform deflection tests of the pipe before acceptance. Optional devices for testing include calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the CITY. To insure accurate testing, the line shall be thoroughly cleaned prior to testing. Testing shall be done no sooner than 30 days after the pipe has been backfilled.

The CONTRACTOR shall schedule the test with the CITY 48 hours prior to the test and the CITY shall be present during the test and shall verify the accuracy of the equipment used. The CITY may require the CONTRACTOR to perform another deflection test prior to the end of the WARRANTY period.

4.39.04 Pressure Test for Pressure Sewers

After the pipe has been laid, including fittings, thrust blocks, and backfill in accordance with the specifications, it shall be subjected to a hydrostatic pressure of not less than 150 P.S.I. for one hour. The allowable leakage shall not exceed the following formula:

$$L = \frac{N \times D \times \sqrt{P}}{148{,}000}$$

L = Allowable leakage in gallons per hour
N = Number of joints in pipe being tested
D = Nominal diameter of pipe in inches
P = Average test pressure in psi.

Each valved section or the entire line if there are no valves, shall be slowly filled with water and the specified test pressure, measured at the highest point of elevation, shall be applied by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection, gauges, and all necessary apparatus shall be furnished by the CONTRACTOR. Gauges and measuring devices shall be approved by the CITY and the necessary taps made as required by the CONTRACTOR. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, brass tapping saddles with corporation stops shall be provided for air release at the highest elevations of the test section and then plugged with brass plugs once the pipeline has passed the test.

Any cracked or defective pipes, fittings, or valves, discovered in the pressure test shall be removed and replaced by the CONTRACTOR with sound material. The test shall be repeated until the pipeline passes the pressure test and is accepted by the CITY.

4.39.05 Manhole Vacuum Test

The CONTRACTOR shall perform these tests with suitable equipment specifically designed for vacuum testing manholes and shall be in accordance with ASTM C1244-05a. The connecting pipes shall be plugged at each manhole with plugs or pneumatic balls and secured in place to prevent displacement during testing operations.

A vacuum of 10 in. of mercury shall be drawn on the manhole. When the vacuum has stabilized, the outlet valve shall be closed and timing shall commence for the test period. Time requirements for minimum test periods are shown in Table 4.39.06 below.

Table 4.39.06 Minimum Time Requirement for Manhole Vacuum Testing

Manhole Depth (ft)	**Time Requirement for Various Manhole Diameters (seconds)**		
	48 in	**60 in**	**72 in**
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89

The manhole test shall pass if the vacuum does not drop below 9 inches of mercury during the time requirement specified.

4.39.06 TV Inspection of Sewers

Following completion of sewer line work, the CONTRACTOR shall perform and supply the CITY with a copy of the PACP TV inspection. TV inspections shall be performed by a PACP certified inspector that is approved by the CITY and use an approved PACP scoring version. A list of preapproved CONTRACTORs and inspectors is available from the PWU, Utilities Operations Division.

Prior to performing the TV inspection, the sewer improvements must be complete, accessible and cleaned using pressurized water sufficient to allow for a detailed inspection. The CITY will not accept inspections for lines that have not been cleaned.

Following TV inspections and any necessary repairs that the CONTRACTOR may have identified, the CITY will review TV inspections. If TV inspections are determined to be acceptable by the CITY, the work will be eligible for acceptance.

Prior to expiration of the CONTRACTORWARRANTY, the CITY will perform a follow-up TV inspection of the sewer system. Any defects found during the WARRANTY TV inspection shall be corrected by the CONTRACTOR.

4.39.07 Pipe Cleaning Prior to Inspections

Sewer cleaning shall be by high-pressure jet cleaning to remove foreign materials from lines. The jet cleaning machine shall be capable of removing

stones, grit, grease, sludge and other debris from the sanitary lines by the scouring action of high pressure water. **Dumping of large volumes of water from hydrants or tankers into the sanitary sewer system is expressly prohibited.**

The jet cleaning machine must be capable of providing a continuous flow of water at a minimum of 40 GPM and 2000 PSI. At a minimum, the cleaner shall use a 90% interior pipe diameter proofer skid at all times. Cleaning shall begin at the upper end of the system and proceed downstream to the outfall. The hose should be brought back at a proper yet steady speed for appropriate and satisfactory cleaning. If necessary, repeat the process to remove all debris. **All debris removed from the cleaning process shall be captured and disposed of as approved by the CITY such that it does not enter the downstream portion of the collection system.**

Sewers found to be improperly cleaned shall be cleaned and re-inspected at the CONTRACTOR's expense.

4.40.00 ABANDONMENT

The abandonment of existing sanitary sewer facilities must be approved in writing by the CITY. Abandonment plans shall include a detailed site plan, facilities affected, proposed new sewer locations, bypass pumping requirements (if necessary) and construction sequencing of the abandoned facilities. No sanitary sewer shall be abandoned until the replacement sewer has been constructed and tested and all service connections have been reconnected. Any sanitary sewers that will be abandoned in place or removed shall be drained and flushed to remove any remaining debris. Debris shall be disposed of properly and shall not be flushed into the downstream sewer.

4.40.01 Pipes

Sewer pipes can be removed or abandoned in place with lean concrete or flowable fill and shall be plugged upstream and downstream of the abandoned section. If a structure is to be removed completely, all sewer lines shall be plugged upstream and downstream of the removed structure following removal.

4.40.02 Manholes

Manholes to be abandoned in place shall have all pipes either removed or plugged with lean concrete or flowable fill so they are watertight. No sandbags are allowed to be used as permanent plugs. Manhole tops, cone sections and barrel sections shall be removed to at least six feet below final grade, or to a depth as directed by the CITY. The structure shall then be abandoned in accordance with the detail drawing in the Appendix of these STANDARDS AND SPECIFICATIONS.

4.40.03 Services

Sewer services shall be capped at the wye or tee and a minimum of five feet of service pipe removed upstream of the tap. If a tapping saddle exists, it shall be removed from the pipe and a sewer repair clamp installed over the opening. All repairs shall be backfilled with a concrete cap.

If more than one service tap is required to be abandoned along a sewer main and the spacing between these taps is less than 50 feet, then the pipe between and including the sections at the taps shall be replaced.

4.41.00 BYPASS PUMPING OPERATION

The DEVELOPER shall submit to the PWU a bypass pumping plan for review and approval prior to implementation of the bypass. Minimum and maximum anticipated flows shall be considered for bypass pump and pipe sizing. Prior to pumping, an approved back-up pump and generator with equal capacity to the primary unit shall be required on site. Pumps utilized shall be designed to handle the range of flows anticipated at the work site and within their priming capabilities. Bypass pumps shall have a maximum rating of 55 decibels for sound attenuation.

The CONTRACTOR shall plug off and pump down the sewer manhole or line segment in the immediate work area and shall maintain the wastewater system so that surcharging does not occur. Where work requires the line to be blocked beyond normal working hours and bypass pumping is being utilized, the CONTRACTOR shall be responsible for monitoring the bypass operation around the clock.

Adequate containment of potential spills shall also be provided to protect local drainage ways. The CONTRACTOR shall complete the work as quickly as possible and satisfactorily pass all tests, inspections and repair all deficiencies prior to discontinuing bypassing operations and returning flow to the sewer manhole or line segment. Concrete shall have the appropriate cure time prior to reinstating flow into the new sewer system.

The CONTRACTOR shall immediately notify the CITY should a sanitary sewer overflow or spill occur and take the necessary action to clean up and disinfect the spillage to the satisfaction of the CITY and/or other governmental agency with jurisdiction.

The CONTRACTOR shall be responsible for all required pumping, equipment, piping and appurtenances to accomplish the bypass and for any and all damage that results directly or indirectly from the bypass pumping equipment, piping, appurtenances and operation. The CONTRACTOR shall also be liable for all CITY personnel and equipment costs, penalties and fines resulting from sanitary sewer overflows and sewer backups. It is the intent of these specifications to require the

CONTRACTOR to establish an adequate bypass pumping plan regardless of the flow or site conditions.

4.50.00 MATERIAL SPECIFICATIONS

4.51.00 GENERAL

Only those pipeline materials described in this section are approved for sanitary sewer installations. Any other material proposed as an equal shall be reviewed by the CITY prior to construction. All pipe materials to be incorporated in the construction of sanitary sewers shall conform to the requirements specified herein or as modified elsewhere in these STANDARDS AND SPECIFICATIONS. All materials furnished shall be new and undamaged. Everything necessary to complete all installations shall be furnished and installed whether shown on the approved drawings or not, and all installations shall be completed and fully operational. Acceptance of materials or the waiving of inspection thereof shall in no way relieve the developer of the responsibility for furnishing materials meeting the requirements of these STANDARDS AND SPECIFICATIONS.

All materials delivered to the job site shall be adequately housed and protected to ensure the preservation of their quality and fitness for the work.

4.52.00 DEFECTS

The presence of any of the following defects in an individual pipe, or in a shipment of pipe, may constitute sufficient cause for rejection of the pipe. Rejected materials shall be removed from the work site within 24 hours unless otherwise permitted by the CITY.

- Pipe length varying more than two inches from the specified length. Pipe shall not be ordered in random lengths.

- Pipe having a deviation from straight which exceeds the following maximum deviation:

$$\text{Maximum Deviation (inches)} = \frac{\text{Length of Pipe in Feet}}{32}$$

- Pipe damaged during shipment or construction.

- Any deficiencies noted in applicable ASTM Specifications

4.53.00 CERTIFICATION

A manufacturer's certification that material was manufactured and tested in accordance with applicable ASTM designations, together with a report of all test results, may be required by the CITY prior to final acceptance of the WORK.

4.54.00 PIPE

4.54.01 Polyvinyl Chloride Pipe (PVC)

All pipe materials and fittings shall meet the minimum requirements of ASTM D-3034, SDR-35 PVC pipe, latest revision. Sewer pipes deeper than 20 feet from finished ground elevation to pipe invert shall be ASTM D-3034, SDR 26 PVC. Pipe shall be subjected to drop-impact tests in accordance with ASTM D-2444. Pipe stiffness for all pipe sizes shall be tested in accordance with ASTM D-2412. Joint tightness shall be tested in accordance with ASTM D-3212.

The pipe shall have bell and spigot joints with gasketed joints. The spigot end shall be marked so the installer and the inspector can determine when the pipe is properly inserted into the bell. The maximum pipe length shall be twenty feet.

The minimum wall thickness based on pipe diameter is shown in the table below.

Pipe Diameter (Inches)	4	6	8	10	12	15	18
Wall Thickness (Inches)	0.125	0.180	0.240	0.300	0.360	0.437	.536

All fittings and accessories shall be as manufactured and furnished by the pipe supplier and have bell and/or spigot configurations compatible with that of the pipe. PVC pipe and all fittings shall conform to these STANDARDS AND SPECIFICATIONS.

4.55.00 MANHOLES

4.55.01 General

Manholes and traffic lids shall be precast and conform to ASTM Standard Designation C-478. All traffic lids shall be designed for AASHTO H-20 traffic loading. Concrete reducing sections (concentric cones) shall not be used. Concrete extension collars shall be used to bring the manhole ring and cover up to the approved street or ground surface elevation in accordance with the detail drawings in the Appendix of this Chapter.

Concrete used in the manufacturing or construction of manholes shall be a minimum of Class D concrete in accordance with these STANDARDS AND SPECIFICATIONS.

Precast manhole barrel sections and cones shall be manufactured in conformity with ASTM Designation C-478.

Manhole ladder rungs shall meet the requirements of ASTM C-478, AASHTO M-199 and the most current OSHA requirements. Rungs shall be consist of polypropylene coated steel, such as that manufactured by M.A., or equal.

4.55.02 Manhole Rings and Covers

All standard cast iron manhole rings and covers and other iron castings shall conform to the requirements of AASHTO M105/ASTM A48 Class 35B. Ductile Iron castings shall conform to the requirements of AASHTO M105 and M306/ASTM A536.

All castings shall conform to Federal Specification RR-F-621E, for shape and dimension required. Castings shall be free from sand, blowholes, shrinkage, cracks, and other cold shuts and be well cleaned by shot blasting. Runners, risers, fins, and other cast-on pieces shall be removed from the castings and ground smooth. Bearing surfaces between manhole rings and covers shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. Fittings shall be hot dipped, factory applied, water base, asphalt paint to form a firm and tenacious coating.

Standard manhole covers shall have nominal diameters of 24 inches for sewer mains 21 inches and smaller and nominal diameters of 30 inches for sewer mains 24 inches and larger.

Standard manhole ring and covers shall be EJ as identified in the table below, or approved equal. Refer to the detail drawings in the Appendix of these STANDARDS AND SPECIFICATIONS.

Nominal Cover Diameter (inches)	Actual Cover Diameter (inches)	Product Number Cover/Frame
24”	23-7/8”	EJ 240585/242013
30”	30”	EJ 250843/250811

All manhole ring and covers located outside of paved roadways shall be locking and hinged type and shall be made of ductile iron. Hinged ring and covers shall be ergonomically designed for worker safety and locks shall securely fasten the cover to the ring using a stainless steel cam lock assembly. Covers shall be capable of opening to 120 degrees from the closed position and shall have a safety catch at 90 degrees to prevent accidental closure.

Locking and hinged manhole ring and covers shall be EJ as identified in the table below. Refer to the detail drawings in the Appendix of these STANDARDS AND SPECIFICATIONS.

Nominal Cover Diameter (inches)	Actual Cover Diameter (inches)	Product Number Cover/Frame

24”	26-3/16”	EJ 1040010L01
32”	32”	EJ 41421092L01

4.55.03 Manhole Bases

Manhole bases shall typically be precast, although cast in place bases may be approved for certain applications such as connections to existing sewer pipes. The base shall be designed to uniformly support AASHTO H-20 traffic loading and any earth loading. The minimum base thickness shall be eight inches below bottom of the pipe and 2-inches above the top of the pipe. Bases shall conform to the detail drawings in the Appendix of these STANDARDS AND SPECIFICATIONS.

4.55.04 Joint Material

Joint material used to set barrel sections shall be a flexible butyl resin joint sealing compound meeting Federal Specifications SS-S-210 (210-A) and AASHTO M 198 75 1 and ASTM C990-09. Ramnek, or approved equal, shall be used.

Interior horizontal joints shall be plastered and troweled smooth with cement mortar.

Exterior horizontal joints shall be wrapped with ConWrap joint wrap, or approved equal, and secured to the concrete to provide a watertight seal.

4.55.05 Mortar

Mortar shall be composed of one part Portland cement and not more than three nor less than two parts of fine aggregate. Hydrated lime or masonry cement shall not be used. Portland cement shall meet the requirements of ASTM C-250, Type II. Fine aggregate shall consist of well-graded natural sand having clean, hard, durable, uncoated grains, free from organic matter, soft or flaky fragments or other deleterious substances. The fine aggregate shall be thoroughly washed and shall be uniformly graded from coarse to fine with a minimum of 95 percent passing a No. 4 sieve and a maximum of seven percent passing a No. 100 sieve.

4.55.06 Interior Coating

Manhole interior coatings shall be required on all newly constructed sewers fifteen inches and larger or any other new or existing sewer manhole downstream of a discharge source that may be determined to be problematic by the CITY. Application of the manhole coating shall follow manufacturer’s recommendations.

The following interior coatings have been approved by the :CITY:

Coating Name	Coating Type	Manufacturer
Spectrashield	Poly-Urea Polymer/Polyurethane	CCI Spectrum

4.55.07 Exterior Coating

Bituminous coatings shall be required on all newly constructed manhole exteriors for waterproofing and to reduce infiltration. The entire exterior surface of concrete manholes (whether precast or cast-in-place) shall receive two coats of waterproofing at a minimum thickness of 7 mils per coat and a total thickness of 14 mils. In no case shall the thickness per coat be less than that recommended by the manufacturer. Application shall follow the manufacturer's recommendations.

The following exterior coatings have been approved by the CITY:

Carboline Bitumastic 300M by SOMAY Products, Inc.
MasterSeal HLM 5000 by BASF.

Equal products to those listed above will be considered for approval.

TABLE OF CONTENTS

CHAPTER 5
STORM SEWER SYSTEM

Page

5.00.00 INTRODUCTION 5-1

5.01.00 USE OF STORM SEWER 5-1

5.10.00 DESIGN CRITERIA 5-1

5.20.00 CONSTRUCTION SPECIFICATIONS 5-1

5.21.00 EXCAVATION AND TRENCHING 5-1
5.22.00 BEDDING 5-1
5.22.01 Granular Bedding 5-1
5.22.02 General 5-2
5.23.00 PIPELINE INSTALLATION 5-2
5.23.01 General 5-2
5.23.02 Pipe 5-2
5.24.00 MANHOLE CONSTRUCTION 5-3
5.24.01 Cast-in-Place Base 5-3
5.24.02 Pre-Cast Base/Inverts 5-4
5.24.03 Pre-Cast Barrel 5-4
5.24.04 Inlets 5-4
5.24.05 Manhole/Inlet Grouting Treatment 5-4
5.24.06 Adjustment Rings 5-5
5.24.07 Underdrains and Other Connections 5-5
5.25.00 CONNECTIONS TO EXISTING MANHOLES 5-5

5.40.00 MATERIAL SPECIFICATIONS 5-5

5.41.00 GENERAL 5-5
5.42.00 DEFECTS 5-6
5.43.00 CERTIFICATION 5-6
5.44.00 PIPE 5-6
5.44.01 Reinforced Concrete Pipe (RCP) 5-6
5.45.00 MANHOLES 5-8
5.45.01 General 5-8
5.45.02 Manhole Rings and Covers 5-8
5.45.03 Manhole Base Slabs 5-9
5.45.04 Joint Material 5-9
5.46.00 INLETS 5-9
5.46.01 General 5-9

CHAPTER 5
STORM SEWER SYSTEM

5.00.00 INTRODUCTION

All storm sewer systems shall comply with the requirements of the "City of Westminster Storm Drainage and Technical Criteria Manual", herein will be referred to as CRITERIA and these STANDARDS AND SPECIFICATIONS.

5.01.00 USE OF STORM SEWER

The stormwater sewer system includes, but not limited to pipes, culverts, inlets, manholes, underdrains, and stormwater treatment facilities. The use of storm sewers within the City of Westminster shall be in accordance with Title VIII, Chapter 8, of the CITY CODE.

5.10.00 DESIGN CRITERIA

CRITERIA shall be the design criteria for the analysis and design of storm drainage facilities within the City of Westminster. All subdivisions, resubdivisions, planned unit development, or any other proposed construction submitted for approval under the provisions of the CITY CODE shall include adequate storm drainage system analysis and appropriate drainage system plans in conformance with the requirements of the CRITERIA.

5.20.00 CONSTRUCTION SPECIFICATIONS

5.21.00 EXCAVATION AND TRENCHING

Excavation, trenching and backfilling shall be done in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

5.22.00 BEDDING

5.22.01 Granular Bedding

Granular Bedding is defined as that method of bedding in which the pipe is set on granular material meeting the requirements of Chapter 9 in these STANDARDS AND SPECIFICATIONS. Bedding shall be placed to a depth below the bottom of the pipe equal to one-fourth of the outside pipe diameter but not less than four inches. In the occurrence of rock excavation the CONTRACTOR shall submit means and methods to the CITY ENGINEER for approval. In rock excavation the minimum depth below the pipe shall be six inches. Granular material shall be placed around the sides of the pipe to a depth of 9 inches over the top of the pipe.

5.22.02 General

In the event unstable trench conditions are found at pipeline grade, a minimum of one and one-half inch uniformly graded, washed rock shall be used for trench stabilization. Depth of stabilization shall be as approved by the CITY. Pipe bedding shall be done in accordance with Section 5.22.01 of these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter.

5.23.00 PIPELINE INSTALLATION

5.23.01 General

The CITY shall be notified at least 48 hours in advance of any pipe installation. No pipes shall be backfilled until they have been inspected by the CITY INSPECTOR. Alignment and grade of the pipe and the location of fittings, manholes and inlets shall be staked under the supervision of a Professional Land Surveyor registered in the State of Colorado.

Proper implements, tools and facilities shall be provided and used by the contractor for the safe and convenient execution of the work. All pipe sections and pre-cast manholes shall be carefully lowered into the trench by suitable tools or equipment to prevent damage to storm sewer line material. Under no circumstances shall storm sewer line materials be dropped or dumped into the trench.

All pipe fittings shall be carefully examined for cracks and other defects immediately before installation. The groove in the bells of the pipe shall be full and continuous or the pipe will be rejected. Defective pipe or fittings shall be removed from the job site within 24 hours of notification by the CITY. All foreign matter or dirt shall be removed from the interior and ends of the pipe before they are lowered into position in the trench and prior to connection.

Every precaution shall be taken to prevent foreign material and trench water from entering the pipe and fittings. For further requirements see 9.03.01 (B). During construction, the CONTRACTOR shall provide and maintain adequate equipment to properly remove and dispose of all water entering the trench and any other part of the WORK.

5.23.02 Pipe

Pipe shall be laid from downstream to upstream with spigot ends pointing downstream. All pipe shall be placed true to line and grade and carefully centered and with a smooth invert at the joint. The joint shall be made in a workmanlike manner and shall be watertight. Immediately before joining two lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned. The spigot end of the pipe shall be placed in the bell with care to prevent the joint from contacting the ground. The joint

shall be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements. The pipe shall then be properly set and brought to correct line and grade. All lifting holes shall be filled with cement mortar prior to backfilling only if they penetrate all the way through the pipe. The pipe shall be secured in place by installation of bedding material and backfill, in accordance with Chapter 9 and the detailed drawings in the Appendix of this Chapter.

Pipe deflections are not to exceed manufacturer's recommendations.

Cutting of pipe for inserting closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining, leaving a smooth end at right angles to the axis of the pipe.

No structure shall be installed upon a foundation in which frost has penetrated or at any time when the CITY INSPECTOR deems there is a danger of ice formation or frost penetrations at the bottom of the excavation. No structure shall be installed unless backfilling can be completed before the formation of ice and frost.

5.24.00 MANHOLE CONSTRUCTION

5.24.01 Cast-in-Place Base

Cast-in-place bases may be allowed with approval of the CITY ENGINEER and shall be in conformance with this section.

Manhole bases shall be constructed with CDOT Class D concrete, placed on undisturbed ground and in conformance with the detail drawing in the Appendix of this Chapter. Changes in direction of flow through the manhole shall be made with a smooth curved channel having as large a radius as possible. The change in size of channels shall be made gradually and evenly and shall be formed directly in the concrete. The floor of the manhole outside of the channel shall be finished to a brushed surface. Cast-in-place bases may be used for storm sewer connection to an existing pipe or as approved by the CITY.

Concrete bases shall extend at least eight inches below the invert of the pipe and shall be benched to at least two inches over the top of the pipe. The manhole floor between the storm sewer pipe and the outer portions of the bench shall be flush with the top edges at the pipe spring line and shall slope upward at least two inches per foot.

Where it is not practicable to use split pipe through manholes due to breaks in alignment, grade, or elevation of intersecting storm sewers, the storm sewer invert shall be made of concrete deposited between forms. The shape of the invert shall conform to the lower half of the pipe it connects. Side branches shall be constructed with as large a radius of curvature as possible. Inverts shall be plastered with cement mortar and left smooth and clean. Where called for

on the plans, a pipe bell shall be stubbed out and plugged. The bell shall be placed as close to the manhole wall as possible, unless shown otherwise on the approved plans.

Bases shall be reinforced with a grid of #4 rebar on 12 inch centers and bars aligned perpendicular. Reinforcement shall be approved by the CITY INSPECTOR prior to installation.

5.24.02 Pre-Cast Base/Inverts

The ground surface below the precast concrete base shall be excavated six inches below the elevation of the bottom of the base and backfilled with three quarter inch gravel meeting the requirements of Chapter 9 of these STANDARDS AND SPECIFICATIONS. The gravel shall be carefully leveled and smoothed to give uniform support to the precast base over its entire area. The precast base shall be set at the proper location to center the manhole over the storm sewer main. The precast base shall also conform to the requirements of these STANDARDS AND SPECIFICATIONS.

5.24.03 Pre-Cast Barrel

Precast manhole sections shall not be placed on the foundation until it has reached sufficient strength to provide support without damage. The joint between the manhole base and the barrel section shall be made with a flexible butyl resin joint sealing compound or as approved by CITY ENGINEER. Each succeeding precast section shall be joined in a similar manner and smoothly finished, inside and out. The interior shall have a smooth grout finish. Exterior horizontal joints shall be wrapped with ConWrap joint wrap, or approved equal, and secured to the concrete to provide a watertight seal. Pre-cast barrel section height shall not exceed48".

5.24.04 Inlets

Inlets shall be constructed with CDOT Class D concrete, placed on undisturbed ground and in conformance with the detail drawings in the Appendix of this chapter. The top portion of inlets shall be constructed concurrently within 5 feet of either side of the adjacent curb and gutter to ensure proper alignment of grades unless otherwise permitted in writing by the CITY ENGINEER. Pre-cast inlets may be used as approved by CITY ENGINEER.

5.24.05 Manhole/Inlet Grouting Treatment

The horizontal joints between precast manhole sections shall be plastered and troweled smooth, inside and out, with non shrink grout. The mortar shall be not less than five eighths inch in thickness over the joint and shall extend at least four inches on either side of the joint. All lifting holes and other imperfections in the interior manhole wall shall be filled with cement mortar.

5.24.06 Adjustment Rings

Precast concrete adjustment rings shall be used on top of the cone to support and adjust the manhole frame to the required final grade. Refer to detail ST 2 for maximum depth of rings.

5.24.07 Underdrains and Other Connections

Underdrain connections to the storm sewer system shall be allowed if approved by the CITY ENGINEER and inspected during connection by the CITY INSPECTOR. Other connections not allowed.

5.25.00 CONNECTIONS TO EXISTING MANHOLES

Storm sewer pipe connections to existing manholes where there is no existing pipe stubbed out shall be made in such a manner that the finished work will conform as nearly as practicable to the requirements specified for new manhole construction. The CONTRACTOR shall break out as small an opening in the existing manhole as necessary to insert the new storm sewer pipe. The existing concrete foundation bench shall be shaped to the cross-section of the new pipe in order to form a smooth continuous invert similar to what would be formed in a new concrete base. The downstream invert shall be plugged during construction to prevent storm and non-sewage pollutants from entering the system. The CONTRACTOR shall pump out and clean the manhole before removing the plug. Non-shrink grout shall be used to smoothly finish the new invert and to seal the new line, both inside and outside, so the junction is watertight.

5.40.00 MATERIAL SPECIFICATIONS

5.41.00 GENERAL

Only those pipeline materials described in this section are approved for storm sewer installations. Any other material proposed as an equal shall be approved by the CITY ENGINEER prior to construction. All pipe materials to be incorporated in the construction of storm sewers shall conform to the requirements specified herein or as modified elsewhere in these STANDARDS AND SPECIFICATIONS. All materials furnished shall be new and undamaged. Everything necessary to complete all installations shall be furnished and installed whether shown on the approved drawings or not, and all installations shall be completed and fully operational. Acceptance of materials or the waiving of inspection thereof shall in no way relieve responsibility for furnishing materials meeting the requirements of these STANDARDS AND SPECIFICATIONS.

All materials delivered to the job site shall be adequately housed and protected to ensure the preservation of their quality and fitness for the work.

5.42.00 DEFECTS

The presence of any of the following defects in an individual pipe, or in a shipment of pipe, may constitute sufficient cause for rejection of the pipe. Rejected materials shall be removed from the work site within 24 hours unless otherwise permitted by the CITY ENGINEER.

- Pipe length varying more than two inches from the specified length. Pipe shall not be ordered in random lengths.

- Pipe having a deviation from straight which exceeds the following:

  $$\frac{\text{Length of Pipe in Feet}}{32} = \text{Maximum Deviation in Inches}$$

- Porous areas on either the inside or the outside surface of a pipe having an area of more than five square inches and a depth of more than one-half inch.

- Pipe which has been patched or repaired - Exposure of the reinforcement.

- Pipe damaged during shipment or construction.

- Any deficiencies noted in applicable ASTM Specifications.

5.43.00 CERTIFICATION

A manufacturer's certification that material was manufactured and tested in accordance with applicable ASTM designations, together with a report of all test results, may be required by the CITY INSPECTOR prior to final acceptance of the work.

5.44.00 PIPE

5.44.01 Reinforced Concrete Pipe (RCP)

All RCP used in the construction of a storm sewer system within the RIGHT-OF-WAY shall conform to the following specifications:

Pipe – ASTM C76 – Reinforced Concrete Culvert, Storm Drainage and Sewer Pipe for Class II, III, IV, and V.

TABLE 5.44.01

Maximum Fill Heights for Reinforced Concrete Pipe
In Clay Soils with Granular Bedding

PIPE SIZE (INCHES)	CLASS II		CLASS III		CLASS IV		CLASS V
			MAXIMUM COVER (FEET)				
18	>		11		16		25+
21	>		11		16		25+
24	>		11		17		25+
30	>		11		17		25+
36	>		11		17		26+
42	8		11		17		27+
48	9		12		17		27+
54	9		12		17		27+
60	9		12		17		27+
66	9		12		17		27+
72	10		12		18		28+
78	10		12		18		28+
84	10		13		18		28+
90	10		13		18		28+
96	10		13		18		28+
102	10		13		18		28+
108	10		13		18		28+
114	10		13		18		28+
120	10		13		18		28+
144	10		13		18		28+

For Greater fill depths, consult Concrete Pipe Design Manual

***** MINIMUM COVER FOR ALL CLASSES OF PIPE SHALL BE 12" BELOW TOP OF SUBGRADE**

Joints – ASTM C443 – Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.

O-Ring/Profile Rubber Gaskets – AASHTO M198

All RCP shall be constructed with Type II modified cement. The absorption of the pipe shall not exceed 5.5 percent.

All concrete pipe fittings, wyes, tees, and bends shall be cast as an integral part of the pipe to which they are attached and shall be the same pipe classification.

The following shall be clearly marked on the exterior surface of all pipe with waterproof paint.

- ASTM Specification.
- Class and Size.

- Date of Manufacture.

- Name or Trademark of Manufacturer.

5.45.00 MANHOLES

5.45.01 General

Manholes, reducing sections, ladder rungs and traffic lids shall be precast and conform to ASTM C-478 and be no larger than 48" in height. All traffic lids shall be designed for AASHTO HS-20 traffic loading. All ladder rungs or manhole steps shall be cast into the manhole barrel when the manhole barrel is poured unless approved otherwise, in writing, by the CITY. Concrete reducing sections shall not be used. Concrete extension collars shall be used to bring the manhole ring and cover up to approved street or ground surface elevation.

Concrete used in the manufacturing or construction of manholes shall be a minimum of Class D concrete in accordance with Chapter 7 of these STANDARDS AND SPECIFICATIONS.

Precast manhole risers and cone sections shall be manufactured in conformity with ASTM Designation C-478.

Concentric cones are not allowed.

5.45.02 Manhole Rings and Covers

All cast iron manhole rings and covers and other iron castings shall conform to the requirements of AASHTO M105/ASTM A48 Class 35B. Ductile Iron castings shall conform to the requirements of ASTM A536. All castings shall conform to Federal Specification RR-F-621E, for shape and dimension required. Castings shall be free from sand, blowholes, shrinkage, cracks, and other cold shuts and be well cleaned by shot blasting. Runners, risers, fins, and other cast-on pieces shall be removed from the castings and ground smooth. Bearing surfaces between manhole rings and covers shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact.

Manhole frame or ring dimensions shall be 24" diameter, 8" tall or as otherwise approved.

Cast iron ring and covers shall have a combined weight of not less than 365 pounds.

Fittings shall be hot dipped, factory applied, water base, asphalt paint to form a firm and tenacious coating.

Acceptable product is EJ #2405A, Product #240565 (storm vault only) or approved equal.

5.45.03 Manhole Base Slabs

Manhole base slabs may be poured in place or precast. The slab shall be designed to uniformly support AASHTO HS-20 traffic loading and any earth loading. The minimum cast in place slab thickness shall be eight inches. The minimum reinforcement in the base slab shall conform to the detail drawings of this Chapter.

5.45.04 Joint Material

Joint material used to set barrel sections shall be a flexible buytl resin joint sealing compound meeting Federal Specifications SS-S-00210-A and AASHTO M 198-B.

5.46.00 INLETS

5.46.01 General

Concrete used in the manufacturing or construction of inlets shall be a minimum of Class D concrete in accordance with Chapter 7 of these STANDARDS AND SPECIFICATIONS.

Manhole ring and cover for Type R inlets shall conform to Section 5.45.02.

TABLE OF CONTENTS

CHAPTER 6

ROADWAY

Page

6.00.00 GENERAL PROVISIONS 6-1

6.01.00 APPLICABILITY 6-1
6.02.00 VARIANCES 6-1
6.03.00 PRIVATE STREET SYSTEMS AND PARKING LOTS 6-1

6.10.00 ROADWAY DESIGN AND TECHNICAL CRITERIA 6-1

6.11.00 REPORTS 6-3
6.11.01 Submittal Format 6-3
6.11.02 Traffic Analysis Report 6-3
6.11.03 Pavement Design Report 6-3
6.12.00 LOCAL STREET 6-3
6.12.01 Local 6-3
6.12.02 TMUND Local Streets 6-4
6.13.00 COLLECTOR STREET 6-4
6.13.01 Minor Collector 6-4
6.13.02 Major Collector 6-5
6.13.03 TMUND Collector Streets 6-6
6.14.00 ARTERIAL STREET 6-6
6.14.01 Minor Arterial 6-6
6.14.02 Major Arterial (4-Lane) 6-7
6.14.03 Major Arterial (6-Lane) 6-8
6.15.00 DRAINAGE 6-9
6.15.01 Crosspans 6-9
6.15.02 Inlets 6-9
6.15.03 Sidewalk Chases 6-9
6.16.00 HORIZONTAL ALIGNMENT 6-9
6.16.01 Horizontal Curves 6-9
6.16.02 Curb Return Radius 6-10
6.16.03 Design Speed 6-10
6.16.04 Spiral Curves 6-11
6.16.05 Small Deflection Angles 6-11
6.16.06 Compound Curves 6-11
6.16.07 Reversing Curves 6-11
6.16.08 Broken-Back Curves 6-11
6.16.09 Alignment at Bridges 6-12
6.16.10 Coordination With Vertical Alignment 6-12
6.17.00 VERTICAL ALIGNMENT 6-12
6.17.01 Permissible Roadway Grade 6-13
6.17.02 Permissible Intersection Grades (Public Rights-of-Way) 6-13
6.17.03 Changing Grades 6-14
6.17.04 Vertical Curves 6-15

6.17.05 Intersections *6-15*
6.17.06 Curb Returns *6-16*
6.17.07 Curb Return Profiles *6-16*
6.17.08 Connection with Existing Roadways *6-17*
6.18.00 SIGHT DISTANCES 6-17
6.18.01 General *6-17*
6.18.02 Sight Distance Triangle *6-18*
6.19.00 ROADWAY CROWN 6-24
6.19.01 Cross Slope *6-24*
6.19.02 Superelevation *6-24*
6.20.00 SIDEWALKS, CURB AND GUTTERS, RAMPS, AND DRIVEWAYS 6-26
6.21.00 CUL-DE-SACS 6-27
6.22.00 DECELERATION LANES 6-27
6.23.00 TRANSIT AND BUS PULL-OUT LANES 6-28
6.24.00 OFF-SITE DESIGN 6-29

6.30.00 PAVEMENT DESIGN AND TECHNICAL CRITERIA 6-29

6.31.00 GENERAL 6-29
6.32.00 SUBGRADE INVESTIGATION 6-30
6.33.00 PAVEMENT DESIGN CRITERIA 6-30
6.33.01 General *6-30*
6.33.02 Equivalent (18 Kip) Single Axle Load Applications (ESAL) *6-30*
6.33.03 Design Serviceability Loss (APSI) *6-31*
6.33.04 Reliability *6-31*
6.33.05 Minimum Pavement Section *6-32*
6.33.06 Flexible Pavement Strength Coefficients *6-32*
6.34.00 PAVEMENT DESIGN PROCEDURE 6-33
6.34.01 Flexible Pavements *6-33*
6.34.02 Rigid Pavement *6-36*
6.35.00 SUBGRADE INVESTIGATION AND PAVEMENT DESIGN REPORT 6-36

6.40.00 CONSTRUCTION SPECIFICATIONS 6-38

6.41.00 GENERAL 6-38
6.42.00 COMPACTION IN UTILITY TRENCHES 6-38
6.43.00 EXCAVATION AND EMBANKMENT 6-39
6.43.01 General *6-39*
6.43.02 Clearing and Grubbing *6-39*
6.43.03 Removal of Existing Structures *6-40*
6.43.04 Salvage *6-41*
6.43.05 Disposal *6-41*
6.43.06 Excavation and Embankment *6-41*
6.43.07 Select Borrow Material *6-42*
6.44.00 SUBGRADE PREPARATION AND GRADING 6-42
6.44.01 General *6-42*
6.44.02 Subgrade Stabilization *6-42*
6.44.03 Chemically Treated Subgrade *6-43*
6.44.04 Mechanically Treated Subgrade *6-43*
6.44.05 Subgrade Surface Tolerance *6-43*
6.45.00 SUBBASE CONSTRUCTION 6-44

6.45.01 General *6-44*
6.45.02 Placement and Compaction *6-44*
6.45.03 Subbase Surface Tolerance *6-44*
6.46.00 BASE CONSTRUCTION 6-44
6.46.01 General *6-44*
6.46.02 Base Course *6-44*
6.46.03 Placement and Compaction *6-45*
6.46.04 Base Surface Tolerance *6-45*
6.47.00 HOT MIX ASPHALT CONSTRUCTION 6-45
6.47.01 Hot Mix Asphalt Pavement *6-45*
6.47.02 Tack Coat *6-45*
6.47.03 Grinding *6-45*
6.47.04 Infrared Patching *6-47*
6.48.00 PORTLAND CEMENT CONCRETE PAVEMENT 6-48
6.49.00 APPURTENANT CONCRETE STRUCTURES 6-48
6.49.01 Curb and Gutter Section *6-48*
6.49.02 Sidewalks and Trails *6-48*
6.49.03 Crosspans and Curb Return Fillets *6-49*
6.49.04 Curb Cuts and Driveways *6-49*
6.49.05 Curb Ramps *6-49*
6.49.06 Detectable Warning Tiles *6-49*
6.49.07 Construction Stakes *6-51*
6.49.08 Backfilling *6-51*
6.49.09 Connections with Existing Concrete Curb, Gutter, Inlets, Sidewalk and Drives *6-51*
6.50.00 BRIDGES AND MAJOR DRAINAGE STRUCTURES 6-51
6.50.01 General *6-51*
6.51.00 CRUSHER FINES TRAILS 6-52
6.51.01 General *6-52*
6.51.02 Equipment *6-52*
6.51.03 Layout of Work *6-52*
6.51.04 Weed Control *6-52*
6.51.05 Placement and Compaction *6-53*
6.51.06 Surface Finishing *6-54*
6.51.07 Inspection *6-54*
6.51.08 Repairs *6-54*

6.52.00 MICRO-TRENCHING 6-55

6.52.01 General *6-55*

6.60.00 CONSTRUCTION TRAFFIC CONTROL 6-55

6.60.01 General *6-55*
6.60.02 Pedestrian Traffic *6-55*
6.60.03 Vehicular Traffic *6-56*
6.60.04 Bicycle Traffic *6-57*

6.70.00 MATERIAL SPECIFICATIONS 6-57

6.71.00 BASE 6-57
6.72.00 HOT MIX ASPHALT PAVEMENT 6-58
6.72.01 Description *6-58*

6.72.02 Materials *6-59*
6.72.03 Mix Design and Production Requirements *6-64*
6.72.04 Production *6-67*
6.72.05 Prime and Tack Coat *6-68*
6.72.06 Equipment *6-69*
6.72.07 Placement *6-69*
6.72.08 Longitudinal Joints *6-71*
6.72.09 Transverse Joints *6-71*
6.72.10 Segregation *6-71*
6.72.11 Compaction *6-71*
6.72.12 Utility Adjustments *6-72*
6.72.13 Production Tolerances *6-73*
6.72.14 Conformity with Plans and Specifications *6-73*
6.72.15 Testing and Inspection *6-74*
6.72.16 Crack Seal Required *6-75*
6.73.00 APPURTENANT STRUCTURES CONCRETE 6-75
6.74.00 STRUCTURE BACKFILL MATERIAL 6-76
6.75.00 DETECTABLE WARNING TILES 6-76
6.75.01 General *6-76*
6.75.02 Manufacturers *6-76*
6.75.03 Submittals *6-76*
6.75.04 Tile Requirements *6-77*
6.75.05 Delivery, Storage, and Handling *6-78*
6.75.06 Guarantee *6-78*
6.75.07 Tile Materials *6-78*
6.76.00 CRUSHER FINES AGGREGATE 6-80
6.76.01 Submittals *6-80*
6.76.02 Herbicide *6-80*
6.76.03 Crusher Fines *6-80*

CHAPTER 6
ROADWAY

6.00.00 GENERAL PROVISIONS

6.01.00 APPLICABILITY

This chapter contains minimum criteria to be met on all streets and public alleys designed and constructed in the CITY, both by the DEVELOPER and by the CITY.

6.02.00 VARIANCES

Where any particular minimum requirements contained in this chapter can be shown to be inappropriate when applied to an “out-of-the-ordinary” situation, variances to said minimum requirements will be considered according to the provisions in Chapter 1 of these STANDARDS AND SPECIFICATIONS.

6.03.00 PRIVATE STREET SYSTEMS AND PARKING LOTS

Private street systems and parking lots shall be subject to all minimum requirements of these STANDARDS AND SPECIFICATIONS except that variances, as provided for in Chapter 1, will be considered subject to the review and approval of the CITY ENGINEER.

6.10.00 ROADWAY DESIGN AND TECHNICAL CRITERIA

This section sets forth the minimum design and technical criteria and specifications to be used in the preparation of all roadway plans. Within this chapter, "AASHTO "Green Book" refers to "A Policy on Geometric Design of Highways and Streets" (latest edition) as published by the American Association of State Highway and Transportation Officials.

The adopted Westminster Transportation & Mobility Plan (2021) will also be referenced to guide the planning for and implementation of multimodal transportation improvements in Westminster.

Design criteria are summarized below in Table 6.10.00. Refer to Sections 6.12.00 through 6.14.00 for requirements for each street classification. Roadway widths presented in this section are minimums. Additional widths shall be provided for bicycle lanes, transit lanes, etc. when required by the TRAFFIC ENGINEER.

TABLE 6.10.00
Roadway Design Criteria

Design Element	Major Arterial	Minor Arterial	Major Collector	Minor Collector	Local Detached	Local Attached
Cross Section	See Typical Section Details R1-R3					
Right-of-Way Minimum	130'/155'	130'	104'	90'	59'	53'
Paved Section Minimum (excluding curb & gutter)	60'/82'	60'	44'	30'	30'	30'
Sidewalk Width Minimum	8'/10'[1]	8'/10'[1]	5'	5'	5'	5'
Curb & Gutter Type	6" Barrier	6" Barrier	6" Barrier	6" Barrier	6" Barrier	6" Mountable
Number of Travel Lanes	4 to 6	2 to 4	2 to 4	2	2	2
Travel Lane Width Minimum	10.5'	10.5'	10.5'	10.5'	10'	10'
Bike Lane Minimum	4'	4'	4'	4'	NA	NA
Street Light Spacing Per Side of Roadway[2]	250'	250'	250'	250'	250'	250'
Traffic Volume	30,000	12,000	7,000	7,000	2,500	2,500
Parking Allowed	No	No	No	Select	Yes	Yes
Direct Residential Access	No	No	No	Select	Yes	Yes
Normal Cross Slope	2%	2%	2%	2%	2%	2%
Maximum Superelevation[3]	4%	4%	4%	NA	NA	NA
Minimum Curve Radius	See Table 6.16.01					
Minimum Tangent Between Horizontal Curves	100'	100'	50'	50'	NA	NA
Maximum Street Grade	See Table 6.17.00					
Minimum Street Grade	0.75%	0.75%	0.75%	0.75%	0.75%	0.75%
Maximum Grade at Intersection	See Figure 6.17.01					
Design Speed (Min/Max)	45/50	40/50	35/50	30/35	25	25
Posted Speed (Min/Max)	40/45	35/45	30/45	25/30	25	25
K-Values Crest	See Table 6.17.00					
K-Values Sag	See Table 6.17.00					
Right and Left Turn Lanes	Required at all access points to Arterial roadways. May be required at access points to Collectors as determined at time of development. Minimum dimensions: 100' storage, 100' taper. Arterial/Arterial intersection 200' storage, 100' taper. Storage shall accommodate the 95%ile of future traffic volume. See Table 6.22.02 for taper ratio.					

Notes:
[1] Eight feet typical; ten feet when multi-use path is required.
[2] See the Street Lighting chapter of these STANDARDS AND SPECIFICATIONS for specific requirements.
[3] See Section 6.19.02 for additional information.

6.11.00 REPORTS

6.11.01 Submittal Format

All reports shall be submitted in PDF or similar format to the CITY's online permit system and shall include the seal and signature of the Professional Engineer registered in the State of Colorado who is responsible for the report contents. In addition, all reports shall include the following statement:

"We acknowledge that the City of Westminster's review of this study is only for general conformance with submittal requirements, current design criteria, and standard engineering principles and practices. We are also aware of the provisions of Section 11-6-5(B)3 of the Westminster Municipal Code."

6.11.02 Traffic Analysis Report

All developments, including but not limited to subdivision, Planned Unit Development (PUD), and commercial developments shall require a traffic analysis report giving information and details as may be required by the CITY ENGINEER and as specified in Chapter 8 of these STANDARDS AND SPECIFICATIONS.

6.11.03 Pavement Design Report

All roadway construction in the City of Westminster shall require a pavement design report. The report content shall be in accordance with Section 6.30.00 of these STANDARDS AND SPECIFICATIONS.

6.12.00 LOCAL STREET

6.12.01 Local

Local streets provide direct access to adjacent property. Traffic carried by local streets should have an origin or a destination within the neighborhood and should accommodate all mode types. Local streets are utilized in single family residential areas. Local streets should not intersect major arterial streets.

(A) **Posted Speed Limit.** 25 miles per hour. Posted or prima facia speeds for the various street classifications are normally the same as the design speed of that street.

(B) **Traffic Volumes.** Less than 2,500 vehicles per day.

(C) **Traffic Control.** Stop signs, yield signs, or right-of-way rules for uncontrolled intersections. Traffic requirements in other than residential areas may require special design consideration by the DEVELOPER and TRAFFIC ENGINEER.

(D) **Right-of-Way.** Fifty three feet (53') with attached walk. Fifty-nine feet (59') with detached walk.

(E) **Number of Travel Lanes.** Two (2).

(F) **Access Conditions.** In accordance with Chapter 8 of these STANDARDS AND SPECIFICATIONS.

(G) **Type of Curb and Gutter.** Six inch (6") mountable combination curb, gutter and walk, with attached walk; or six inch (6") vertical with detached walk.

(H) **Sidewalk Width.** Five foot (5') minimum, attached or detached from curb.

(I) **Cul-De-Sacs.** In accordance with Section 6.21.00 of these STANDARDS AND SPECIFICATIONS.

(J) **Street Widths.**

1. Thirty foot (30') paved width (minimum) plus two (2) two foot (2') gutter pans.

6.12.02 TMUND Local Streets

Traditional Multi-Use Neighborhood Development (TMUND) local street sections, as shown in the standard drawings, may be used only in TMUND developments when approved by the CITY ENGINEER.

6.13.00 COLLECTOR STREET

6.13.01 Minor Collector

Collector streets collect and distribute traffic between arterial and local streets and serve as main connectors within communities, linking one neighborhood with another, and should accommodate all mode types. Traffic carried by collector streets should have an origin or a destination within the community. Collector streets should have continuity throughout a neighborhood but need not extend beyond the neighborhood. Intersections with collectors, major collectors, and arterial streets should be at least one quarter (1/4) mile apart.

(A) **Posted Speed Limit.** Between 25 and 30 miles per hour. Posted or prima facia speeds for the various street classifications are normally five (5) to ten (10) miles per hour less than the design speed of that street.

(B) **Traffic Volumes.** Generally less than 7,000 vehicles per day.

(C) **Traffic Control.** Regulation of traffic accomplished through the use of stop signs and channelization. Traffic signals normally use only at intersections with major collectors and arterial streets.

(D) **Driveways.** No back-out drives permitted.

(E) **Right-of-Way Width.** Ninety-feet (90') minimum.

(F) **Number of Travel Lanes.** Two (2).

(G) **Access Conditions.** In accordance with Chapter 8 of these STANDARDS AND SPECIFICATIONS.

(H) **Type of Curb and Gutter.** Six (6) inch vertical.

(I) **Sidewalk Width.** Five feet (5') minimum. Detached from curb.

(J) **Street Widths.** Thirty-foot (30') paved (minimum) with two (2) two-foot (2') gutter pans.

6.13.02 Major Collector

Major collector streets permit relatively unimpeded traffic movement and are intended for use on those routes where two (2) moving lanes are required but where a larger classified street is not warranted. Utilized in industrial, commercial, multi-family, and single family residential areas. Major collector streets should be employed where traffic demands are high, and should accommodate all mode types.

(A) **Posted Speed Limit.** Between 30 and 45 miles per hour. Posted or prima facie speeds for the various street classifications are normally five (5) to ten (10) miles per hour less than the design speed of that street.

(B) **Traffic Volumes.** Generally greater than 7,000 vehicles per day and less than 12,000 vehicles per day, when the land which the collector serves is fully developed.

(C) **Traffic Control.** Regulation of traffic accomplished by signing and channelization. Traffic signals will normally be located only at intersections with streets of higher classification. Parking prohibited.

(D) **Driveways.** No back-out drives permitted.

(E) **Right-of-Way Width.** One hundred four feet (104').

(F) **Number of Travel Lanes.** Four (4).

(G) **Access Conditions.** In accordance with Chapter 8 of these STANDARDS AND SPECIFICATIONS.

(H) **Type of Curb and Gutter.** Six (6) inch vertical.

(I) **Sidewalk Width.** Five feet (5') wide minimum. Detached from curb.

(J) **Street Widths.** Forty-four feet (44') paved (minimum) plus two (2) two-foot (2') gutter pans.

6.13.03 TMUND Collector Streets

Traditional Multi-Use Neighborhood Development (TMUND) collector street sections, as shown in the standard drawings, may be used only in TMUND developments when approved by the CITY ENGINEER.

6.14.00 ARTERIAL STREET

6.14.01 Minor Arterial

Arterial routes permit relatively unimpeded traffic movement and are intended for use on these routes where four (4) moving lanes and one (1) left turn lane are required but where a major arterial cross section would not be warranted. Parking is not allowed and all mode types should be accommodated.

Arterials should be spaced from one half (1/2) to one (1) mile apart and should, where possible, be continuous. Arterials should act as boundaries between neighborhood areas. Arterial cross section should be employed where traffic demands are high. Detached sidewalk and/or multi-use trail required. Separate major land uses.

(A) **Posted Speed Limit.** Between 35 and 45 miles per hour. Posted or prima facie speeds for the various street classifications are normally five (5) to ten (10) miles per hour less than the design speed of that street.

(B) **Traffic Volumes.** Twelve thousand (12,000) vehicles per day expected minimum traffic volume when the land which the arterial serves is fully developed.

(C) **Access.** In accordance with Chapter 8 of these STANDARDS AND SPECIFICATIONS.

(D) **Traffic Control.** Regulation of traffic accomplished by signs and channelization. Traffic signals will normally be located only at

intersections with streets of high classification. Parking shall be prohibited.

(E) **Right-of-Way Width.** One hundred and thirty feet (130') minimum.

(F) **Number of Travel Lanes.** Four (4).

(G) **Type of Curb and Gutter.** Six (6) inch vertical.

(H) **Sidewalk Width.** Eight-foot (8') minimum, or ten-foot (10') multi-use path, detached from curb, or as required by the CITY ENGINEER.

(I) **Street Widths.** Sixty feet (60') paved (minimum) and two (2) two-foot (2') gutter pans plus deceleration lanes at intersections.

6.14.02 Major Arterial (4-Lane)

Major arterial streets permit rapid and relatively unimpeded traffic movement throughout the City of Westminster, connecting major lane use element, as well as communities with one another. No parking is allowed and all mode types should be accommodated. Sidewalks and/or multi-use trails are required.

Major arterial streets should be spaced approximately one (1) mile apart and should traverse the entire City of Westminster. Major arterial streets should not bisect neighborhoods but should act as boundaries between them.

(A) **Posted Speed Limit.** 40 to 45 miles per hour. Posted or prima facie speeds for the various street classifications are normally five (5) to ten (10) miles per hour less than the design speed of that street.

(B) **Traffic Volumes.** Nineteen thousand (19,000) vehicles per day expected minimum traffic volume when the land which the arterial serves is fully developed.

(C) **Access.** In accordance with Chapter 8 of these STANDARDS AND SPECIFICATIONS.

(D) **Traffic Control.** Movement of traffic will be controlled by signals and channelization. Parking shall be prohibited. Roadways should have a raised median strip between them.

(E) **Right-of-Way Width.** One-hundred-thirty feet (130') minimum.

(F) **Number of Travel Lanes.** Four (4).

(G) **Type of Curb and Gutter.** Six (6) inch vertical with two foot (2') pan on outside of traveled way; six (6) inch vertical with one foot (1') pan on medians.

(H) **Sidewalk Width.** Eight-foot (8') minimum, or ten-foot (10') multi-use path, detached from curb, or as required by the CITY ENGINEER.

(I) **Street Widths.** Sixty feet (60') paved (minimum), two (2) two-foot (2') gutter pans plus necessary left-turn and deceleration lanes at intersections.

6.14.03 Major Arterial (6-Lane)

Major arterial streets permit rapid and relatively unimpeded traffic movement throughout the City of Westminster, connecting major land use elements, as well as communities with one another. Parking is not allowed and all mode types should be accommodated. Sidewalks and/or multi-use trails are required.

Major arterial streets should be spaced approximately one (1) mile apart and should traverse the entire City of Westminster. Major arterial streets should not bisect neighborhoods but should act as boundaries between them.

(A) **Posted Speed Limit.** 40 to 45 miles per hour. Posted or prima facie speeds for the various street classifications are normally five (5) to ten (10) miles per hour less than the design speed of that street.

(B) **Traffic Volumes.** Thirty thousand (30,000) vehicles per day expected minimum traffic volume when the land which the arterial serves is fully developed.

(C) **Access.** In accordance with Chapter 8 of these STANDARDS AND SPECIFICATIONS.

(D) **Traffic Control.** Movement of traffic will be controlled by signals and channelization. Parking shall be prohibited. Roadways should have a 4 foot (4') minimum raised median strip between them.

(E) **Right-of-Way Width.** One hundred fifty-five foot (155') minimum.

(F) **Number of Travel Lanes.** Six (6).

(G) **Type of Curb and Gutter.** Six (6) inch vertical with two foot (2') pan on outside of traveled way; six (6) inch vertical with one foot (1') pan on median.

(H) **Sidewalk Width.** Eight-foot (8') minimum, or ten-foot (10') multi-use path, detached from curb, or as required by the CITY ENGINEER.

(I) **Street Widths.** Eighty-two (82') paved (minimum), two (2) two-foot (2') gutter pans and necessary left-turn lanes and deceleration lanes at intersections.

6.15.00 DRAINAGE

The minor and major storm drainage systems shall be designed in accordance with the CRITERIA. The safe and efficient movement of traffic is the primary function of roadways. The storm drainage function of roadways (such as allowable gutter capacity and street overtopping) shall be designed to the limits set forth in the drainage criteria.

6.15.01 Crosspans

Crosspans shall be constructed in accordance with the detail drawing. Crosspans are not permitted perpendicular to collector or arterial roadways, nor are they allowed on roadways with storm sewer systems. Crosspans may be used parallel to collectors or arterial roadways to convey storm runoff across residential roadways. The use of crosspans elsewhere, or the use of any crosspan on roadways where the vertical grade exceeds four-and-one-half percent (4.5%) will be considered only after all alternatives have been exhausted.

6.15.02 Inlets

Inlets shall be located to intercept the curb flow at the point curb flow capacity is exceeded by storm runoff. Refer to the CRITERIA for curb capacity. Inlets shall also be installed to intercept cross-pavement flows at points of transition in superelevation. Due to the presence of handicap ramps, inlets shall not be allowed in the curb return but shall be located outside the tangent points of the curb returns. Gutter transition sections abutting inlets shall not be within the curb return.

6.15.03 Sidewalk Chases

Storm water from concentrated points of discharge shall not be allowed to flow over sidewalks but shall drain to the roadway or storm inlet by use of chase sections. Sidewalk chase sections shall not be located within a curb cut or driveway. Sidewalk chase sections shall be constructed when requested by the CITY ENGINEER and in accordance with the detail drawing.

6.16.00 HORIZONTAL ALIGNMENT

6.16.01 Horizontal Curves

The minimum horizontal curves for roadway alignment shall be in accordance with Table 6.16.01 below.

TABLE 6.16.01
Horizontal Curves

Design Speed (MPH)	Minimum Curve Radius (feet)*
20	107
25	198
30	333
35	510
40	762
45	1039
50**	926
55**	1190

* AASHTO Table 3-13b - for low speed urban street - normal crown.
** Requires Superelevation per AASHTO Table 3-8 - 0.04 ft/ft maximum.

6.16.02 Curb Return Radius

Minimum return radius shall be as shown in Table 6.16.02 below.

TABLE 6.16.02
Curb Return Radii
(Measured Along Flowline)

	Intersecting Streets		
Through Street	Arterial	Collector	Local Service
Arterial	*	30 feet	25 feet
Collector	30 feet	25 feet	20 feet
Local Service	25 feet	20 feet	15 feet

* Special design required and will be reviewed by the CITY ENGINEER. Corner may need to incorporate turn lanes and islands and turning template simulations will be required.

6.16.03 Design Speed

Horizontal alignment design speed shall be consistent with the requirement for vertical alignment design speed. If no superelevation is required and normal crown section exists, the horizontal curve data as shown in Table 6.16.01 shall be used.

6.16.04 Spiral Curves

Spiral curves shall be used only on arterial roadways within the City of Westminster and only upon written approval of the CITY ENGINEER.

6.16.05 Small Deflection Angles

For small deflection angles, curves should be sufficiently long to avoid the appearance of a kink. Curves should be at least five hundred (500) feet long for a central angle of five degrees (5°), and the minimum length should be increased one hundred feet (100') for each one-degree (1°) decrease in the central angle. Horizontal curves should not be used when the central angle is fifty-nine minutes (59') or less. These criteria apply to arterial roadway design only and latest AASHTO criteria will control.

6.16.06 Compound Curves

A compound curve on arterials should be avoided, particularly where a simple curve can be obtained and is reasonably feasible. Where topography makes their use necessary, the radius of the flatter curve should not be more than fifty percent (50%) greater than the radius of the sharper curve. When this is not feasible, an intermediate curve or spiral should be used to provide the necessary transitions. Spiral curves are only to be used upon written approval of the CITY ENGINEER.

6.16.07 Reversing Curves

True reversing curves should not be used. In cases of reversing curves, a sufficient tangent should be maintained to avoid overlapping of the required superelevation runoff and tangent runout. The following is the minimum tangent lengths that shall be used for each roadway classification (if the curves have superelevation, the required transition lengths will control):

(A) Local -- not applicable.

(B) Collector -- Fifty feet (50') minimum.

(C) Arterial -- One hundred feet (100') minimum.

6.16.08 Broken-Back Curves

A broken-back curve consists of two (2) curves in the same direction joined by a short tangent, of length less than one thousand five hundred feet (1500'). Broken-back curves are undesirable. If the length of intervening tangent is less than one thousand five hundred feet (1500'), a simple curve, a compound curve, or spiral transitions should be used to provide some degree of continuous

superelevation. Spiral curves are only to be used upon written approval of the CITY ENGINEER.

6.16.09 Alignment at Bridges

Ending a curve on a bridge is undesirable and adds to the complication of design and construction. Likewise, curves beginning or ending near a bridge should be so placed that no part of the spiral or superelevation transitions extends onto the bridge. Compound curves on a bridge are equally undesirable. If curvature is unavoidable, every effort should be made to keep the bridge within the limits of the simple curve.

6.16.10 Coordination with Vertical Alignment

To avoid the possibility of introducing serious traffic hazards, coordination is required between horizontal and vertical alignment. Particular care must be exercised to maintain proper sight distance at all times. Sharp horizontal curves introduced at or near the top of pronounced crest or bottom of sag vertical curves should be avoided. Vertical curvature superimposed upon horizontal curves, or vice versa, generally results in a more pleasing facility.

6.17.00 VERTICAL ALIGNMENT

Vertical Alignment Control Table:

Design Controls for vertical alignment are shown on Table 6.17.00.

TABLE 6.17.00
Vertical Alignment Controls

Design Speed (MPH)*	Maximum Grade**	Minimum K Value Crest***	Minimum K Value Sag***	Minimum Vertical Curve Length (feet)
25	8%	12	26	50
30	8%	19	37	50
35	8%	29	49	50
40	7%	44	64	50
45	7%	61	79	50
50	7% Collector 6% Arterial	84	96	150
55	6%	114	115	165

* For collector and higher classification roadways, the design speed is a minimum of 5 miles per hour over the posted speed. For local roadways, the design speed is the same as the posted speed.

** The maximum grades indicated should only be used in extreme topographic conditions. The designer should strive to minimize the use of these grades for considerable lengths and on north-facing slopes.

*** K values exceeding 167 on curbed streets should be checked for drainage. Multiple inlets may be required within long sag vertical curves, and where the longitudinal slope is less than 0.4 percent.

6.17.01 Permissible Roadway Grade

The minimum allowable grade for roadways is three-quarter percent (0.75%). The minimum allowable grade for bubbles and cul-de-sacs within the bulb is one percent (1%). The maximum allowable grade for any roadway is shown in Table 6.17.00 above.

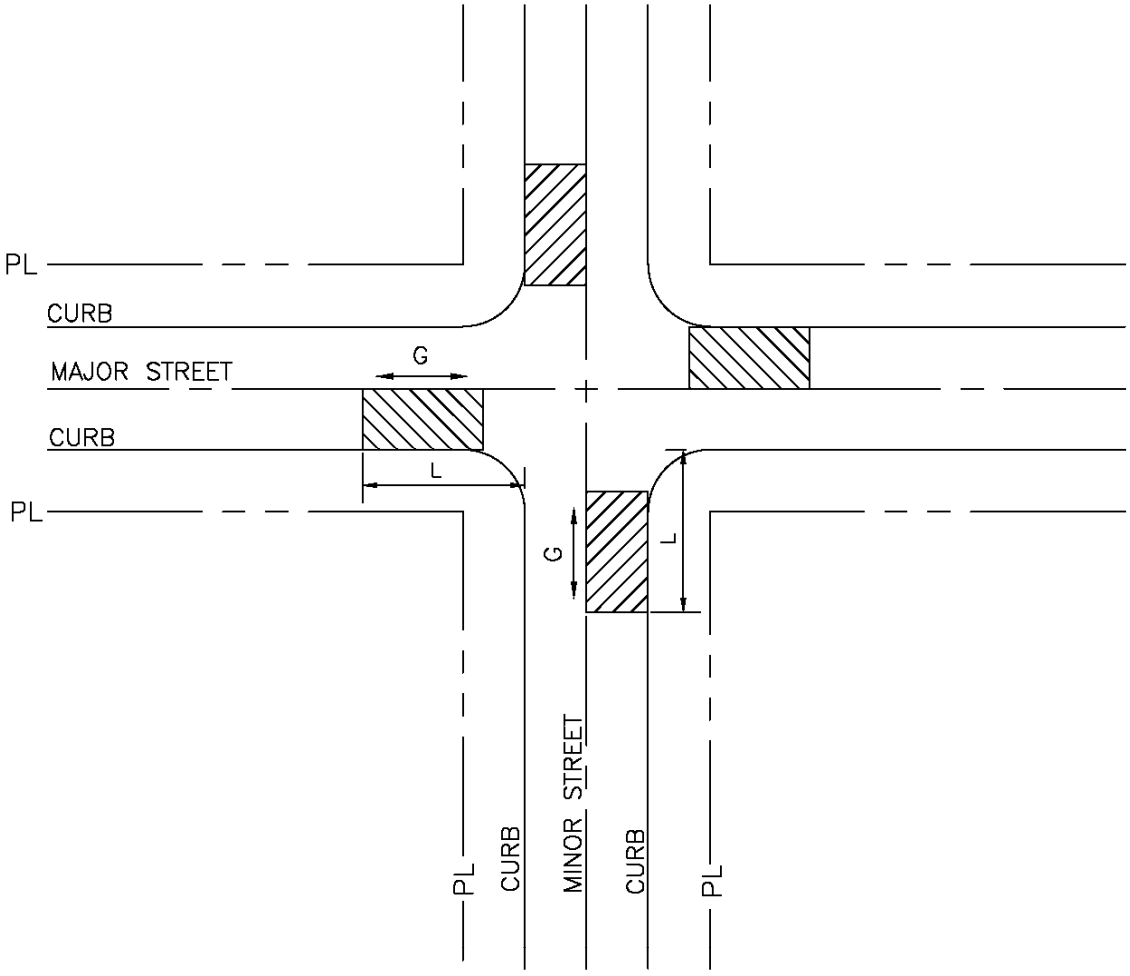
6.17.02 Permissible Intersection Grades (Public Rights-of-Way)

The maximum permissible grade at intersections shall be as shown in Figure 6.17.01. These grades are maximum instantaneous flowline grades for the stated distances (each side of the street) for the minor (intersecting) street.

The intersection grade of the major (through) street at the intersection may be dictated by design considerations for the street. However, if the major street intersection grade exceeds three percent (3%), the type of access and access control will be as directed by the CITY ENGINEER.

All private commercial driveways with curb return radii shall follow the standards set forth for a local street. The length of the maximum grade for the commercial driveway shall be a minimum of fifty feet (50') measured from the flowline intersection of the public roadway.

FIGURE 6.17.01
Maximum Permissible Intersection Grades



MINOR STREET \ MAJOR STREET		LOCAL	MINOR COLLECTOR	MAJOR COLLECTOR	MINOR ARTERIAL	MAJOR ARTERIAL
LOCAL	L	95'	100'	100'	125'	125'
	G	4%	4%	4%	4%	4%
MINOR COLLECTOR	L	--	100'	120'	150'	150'
	G	--	4%	3%	3%	3%
MAJOR COLLECTOR	L	--	--	120'	150'	200'
	G	--	--	3%	3%	3%
MINOR ARTERIAL	L	--	--	--	200'	200'
	G	--	--	--	2%	2%
MAJOR ARTERIAL	L	--	--	--	--	200'
	G	--	--	--	--	2%

6.17.03 Changing Grades

The use of grade breaks in lieu of vertical curves is discouraged. However, if a grade break is necessary and the algebraic difference in grade does not exceed

eight-tenths of a percent (0.008 ft./ft.) along the roadway, the grade break will be permitted. The maximum grade break allowed at the point of tangency at a curb return for local and collector roads shall be two percent (2%) and for arterial roadways a maximum of one percent (1%).

6.17.04 Vertical Curves

When the algebraic difference in grade (A) is at, or exceeds, eight-tenths of a percent, a vertical curve is to be used. Design criteria for vertical curves is found in Table 6.17.00 of this chapter. The minimum gradients into and out of a sag (sump) vertical curve is three-quarters of a percent (0.0075 ft./ft.). Minimum length of a vertical curve is shown in Table 6.17.00 of this chapter. All vertical curves shall be labeled in the profile with length of curve (L), K=L/A values, Vertical Point of Curvature (VPC), Vertical Point of Tangent (VPT), Vertical Point of Intersection (VPI), and stationing and elevation of these components. In addition, the low point or high point of the vertical curve shall be shown.

6.17.05 Intersections

In addition, the following criteria shall apply at intersections.

(A) The grade of the "through" street shall take precedence at intersections. At the intersections of roadways with the same classification, the more important roadway, as determined by the CITY ENGINEER, shall have this precedence. The design should warp side streets to match through streets with as short a transition as possible. Transition lengths shall be according to AASHTO criteria.

(B) The key criteria for determining the elevation of the curb return on the side street and the amount of warp needed on a side street transitioning to a through street are:

1. Permissible grade in the stop/start lane. See Section 6.17.02 of these STANDARDS AND SPECIFICATIONS.

2. Pavement cross slope at the PCR's on the side street and permissible warp in pavement cross slope (see Section 6.19.01(B)).

3. Normal vertical curve criteria.

4. Vertical controls within the curb return itself.

(C) The elevation at the PCR of the curb return on the through street is always set by the grade of the through street in conjunction with pavement cross slope.

(D) Carrying the crown at a side street into the through street is permitted only when drainage considerations warrant such a design.

(E) A more detailed review shall be performed for arterial-arterial intersections to maximize driveability. A few arterial intersections will have a uniform two percent (2%) cross-slope, the majority of them having one or more sides warped.

(F) Whenever possible, intersections shall be made at right angles or radial to a curve. No intersecting angle of less than seventy-five degrees (75°) will be allowed.

6.17.06 Curb Returns

Minimum grade around curb returns for flow along the curb line shall be as follows:

Table 6.17.06
Curb Return Grades

Curb Return Radius (Feet)	Minimum Grade Around Curb Return
15 to 35	1.00%
40 and Greater	0.75%

6.17.07 Curb Return Profiles

Curb return profiles are required for radii equal to or greater than twenty five feet (25') within the public right-of-way. A mid-point elevation along the arc length of the curb return shall be shown in plan view for radii equal to or greater than twenty-five feet (25'). Curb return design shall be set in accordance with the following design procedure. General standards for flowline control and profiles with the curb returns shall be as follows:

(A) The point of tangency at each curb return shall be determined by the projected tangent grade beginning at the point of intersection (PI) of the flowlines.

(B) The arc length and external distances of the curb return shall be computed and indicated on the drawing.

(C) Show the projected flowline (or top of curb) grade for each roadway beyond the PCR.

(D) Design the flowline of the curb return such that a maximum cross slope between the mid-point of the curve and the PICR (external distance) does not exceed five percent (5%). Grade breaks at the PCRs shall not exceed two percent (2%) for local and collector streets and one percent (1%) for arterials. The flowline design of the curb return shall be accomplished within the return without affecting street grades beyond

the PCR. Maximum vertical curves will equal the arc length of the curb return. The elevation and location of the high or low point within the return, if applicable, is to be called out in the profile.

6.17.08 Connection with Existing Roadways

(A) Connection with existing roadways shall be smooth transitions conforming to normal vertical curve criteria if the algebraic difference in grade between the existing and proposed grade exceeds eight-tenths (0.008 ft./ft.) of a percent. When a vertical curve is used to make this transition, it shall be fully accomplished prior to the connection with the existing improvements and shall also comply with the grade requirements at intersection approaches.

(B) Existing grade shall be shown for at least three hundred feet (300') with field verified as-builts showing stations and elevations at twenty-five-foot (25') intervals. In the case of connection with an existing intersection, these as-builts are to be shown within a three-hundred-foot (300') radius of the intersection. This information will be included in the plan and profile that shows that proposed roadway. Limits and characteristics of the proposed improvement are the primary concern in the plan view. Such characteristics include horizontal alignment, off-site intersections, limits of the improvement, etc.

(C) Previously approved designs for the proposed improvement are not an acceptable means of establishing existing grades. However, they are to be referenced on the construction plan where they occur.

(D) The basis of the as-built elevations shall be the design elevations (both flowline or both top of curbs, etc.) when possible.

6.18.00 SIGHT DISTANCES

6.18.01 General

The major considerations in alignment design are safety, grade, profile, road area, design speed, sight distance, topography, drainage, and performance of heavy-duty vehicles. The road alignment should provide for safe and continuous operation at a uniform design speed. New road layout shall bear a logical relationship to existing or platted roads in adjacent properties. Design for sight distances shall be in accordance with the following:

Adequate intersection design necessitates the provision of safe ingress and egress from one street or driveway to the other, based in part on the ability of a driver to see oncoming vehicles or pedestrians. The following guidelines shall be used in the design of intersections, private driveways and public streets which intersect other traffic carrying facilities.

6.18.02 Sight Distance Triangle

At the intersection of two public streets or a private driveway and a public street, sight distance shall be evaluated across a "sight distance triangle" where obstructions are restricted according to the following criteria. Within the area of the triangle there must be no wall, fence, sign, foliage, berming, or other structure which will obscure the driver's view of traffic approaching that intersection. The structures or berms within the sight distance triangle can extend no higher than thirty inches (30") above the curb elevation. Exceptions to this requirement exist for public facilities such as fire hydrants, utility poles, and traffic control devices. These facilities must be located to minimize visual obstruction.

The evaluation of sight distance shall be made on two different types of sight distance areas. The first is shown in Figure 6.18.01 for the intersection of two public streets or a public street and a private driveway. The sight distance triangle in this case is formed by the intersection of two lines plotted along the curb line of the intersecting streets using the specified lengths. The diagonal connects the other ends of those lines. Where one or the other of the intersecting streets/driveways has no curb, the lines are plotted along the edge of the traveled way.

The second sight distance triangle is shown in Figure 6.18.02, and is formed by lines plotted along the flowlines or edge of traveled way of both streets and the diagonal lines d_1 and d_2 as shown. Distance d_1 is measured to vehicles approaching from the left and d_2 is measured to those approaching from the right. The sight lines (d_1 and d_2) have their origin at the stopped driver's eye, located fourteen and a half (14.5') behind the flowline of the street being entered.

Tables 6.18.01 through 6.18.04 show recommended sight distances d_1, and d_2 for passenger vehicles and semi-tractor trailer trucks for several different vehicle operating speeds and roadway configurations. The tables were developed according to the following general criteria:

1. Vehicles turning left or right can accelerate to the operating speed of the intersecting street without causing approaching vehicles to reduce speed by more 70% of their initial speed.

2. Vehicles turning left can clear the near half of the street without conflicting with vehicles approaching from the left.

3. The distance requirements are based on the driver's eye being 3.5 feet above the roadway and an object height of 4.35 feet. For semi-tractor trailers, a 7.6 foot driver's eye height and a 4.35 feet object height are assumed.

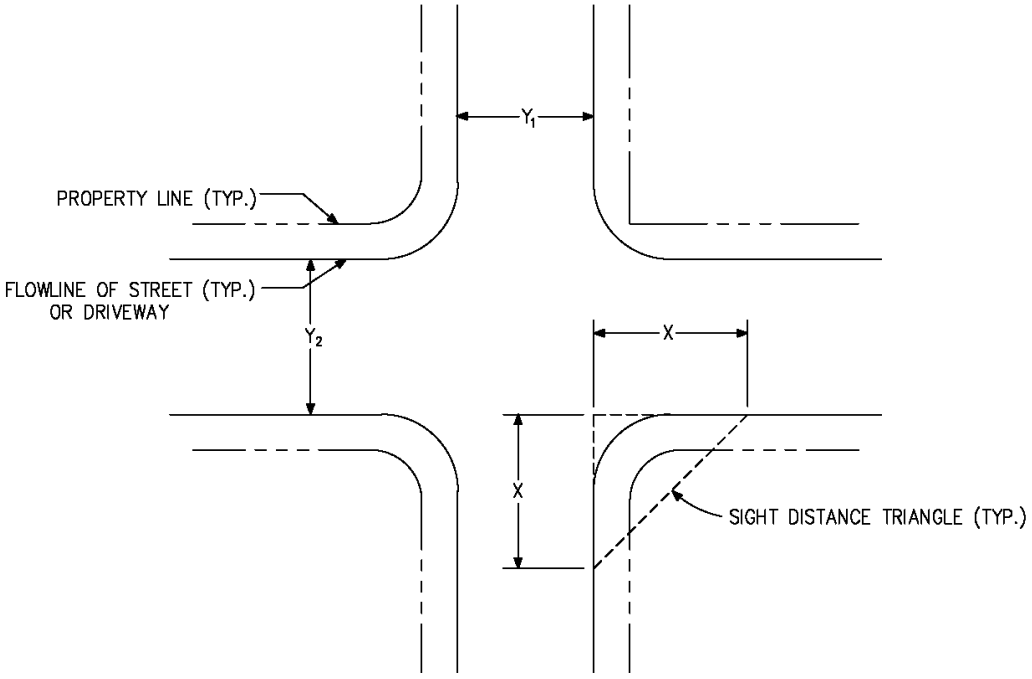
4. The operating speed on each approach is assumed to be (in the order of desirability):

A. The 85th percentile speed;

B. The speed limit, if based on a traffic engineering study;

C. The design speed in the case of a new facility.

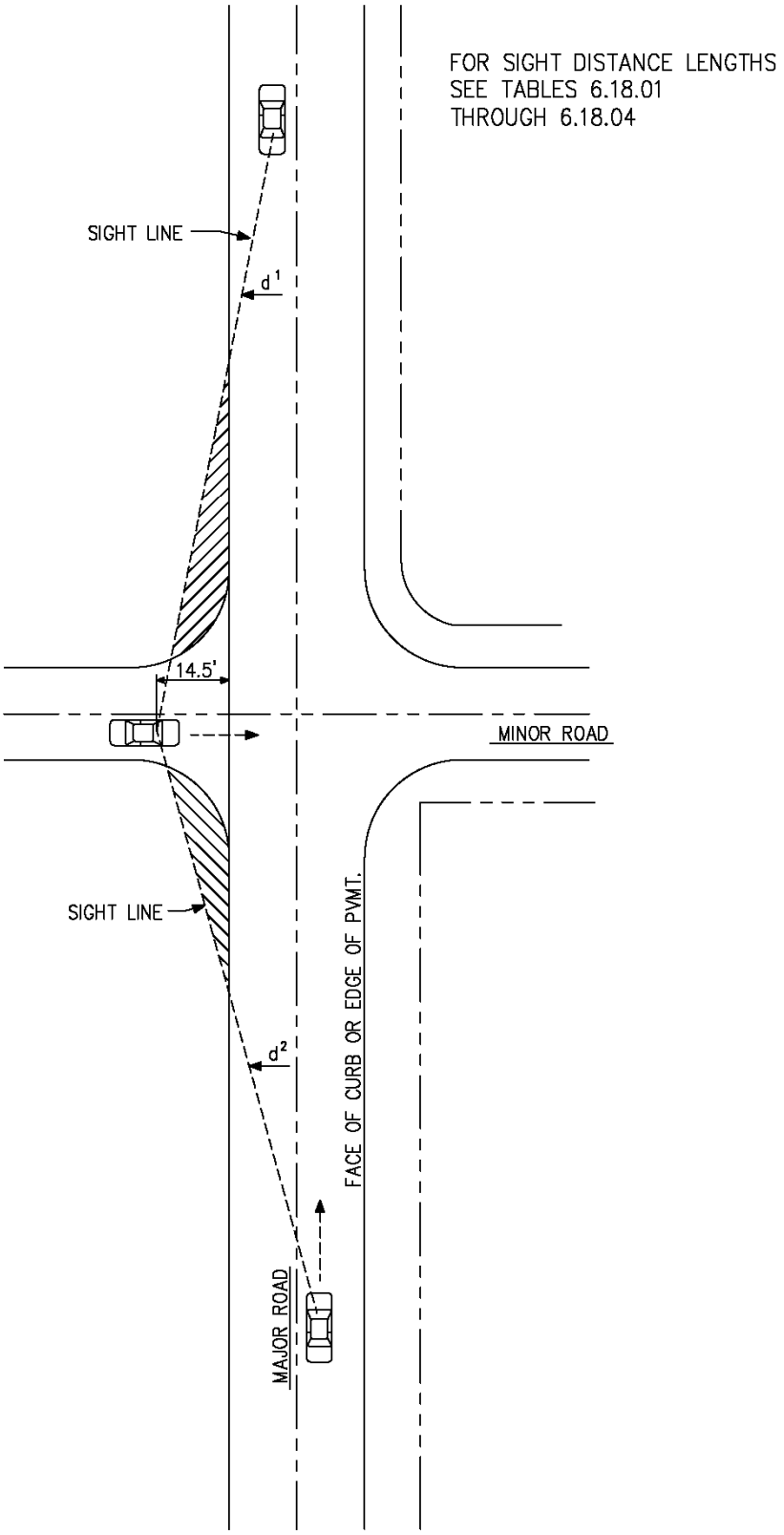
FIGURE 6.18.01
Intersection Sight Lines Case 1



NOTE: IF $Y_1 \neq Y_2$ USE THE LARGER OF THE TWO TO DETERMINE THE "LEG LENGTH" OF THE SIGHT DISTANCE TRIANGLE

FLOWLINE TO FLOWLINE (Y)	LEG LENGTH (X)
≤ 36 FT.	35 FT.
≤ 44 FT.	45 FT.
>= 45 FT.	55 FT.

FIGURE 6.18.02
Intersection Sight Lines Case 2



When the criteria for sight distance cannot be met, the CITY may prohibit certain turns by exiting vehicles to provide safe operating conditions. These standards apply to accesses on State Highways and CITY streets.

TABLE 6.18.01
Sight Distance d^1 and d^2 (feet) for Passenger Cars Turning Left from Private Accesses or Public Streets onto Public Streets

Speed (mph)	Sight Distances d^1 and d^2 (feet)		
	Onto Two-Lane Street	Onto Four-Lane Street	Onto Six-Lane Street
20	225	235	250
25	280	295	315
30	335	355	375
35	390	415	440
40	445	470	500
45	500	530	565
50	555	590	625
55	610	650	690
60	665	710	750

TABLE 6.18.02
Sight Distance (feet) for Passenger Cars Turning Right or Crossing from Private Accesses or Public Streets onto Public Streets

Speed (mph)	Sight Distances (feet)			
	Right Turn (d^1)	Crossing Two-Lane Street (d^1 & d^2)	Crossing Four-Lane Street (d^1 & d^2)	Crossing Six-Lane Street (d^1 & d^2)
20	195	195	225	250
25	240	240	280	315
30	290	290	335	375
35	335	335	390	440
40	385	385	445	500
45	430	430	500	565
50	480	480	555	625
55	530	530	610	690
60	575	575	665	750

TABLE 6.18.03
Sight Distance d^1 and d^2 (feet) for Semi-Trailers Turning Left from Private Accesses or Public Streets onto Public Streets

Speed (mph)	Sight Distances d^1 and d^2 (feet)		
	Onto Two-Lane Street	Onto Four-Lane Street	Onto Six-Lane Street
20	340	360	380
25	425	450	475
30	510	540	570
35	595	630	665
40	680	720	760
45	765	810	855
50	845	900	950
55	930	990	1,045
60	1,015	1,080	1,140

TABLE 6.18.04
Sight Distance (feet) for Semi-Trailers Turning Right or Crossing from Private Accesses or Public Streets onto Public Streets

Speed (mph)	Sight Distances (feet)			
	Right Turn (d^1)	Crossing Two-Lane Street (d^1 & d^2)	Crossing Four-Lane Street (d^1 & d^2)	Crossing Six-Lane Street (d^1 & d^2)
20	310	310	350	395
25	390	390	440	490
30	465	465	525	590
35	540	540	615	685
40	620	620	700	785
45	695	695	790	880
50	775	775	875	980
55	850	850	965	1,075
60	930	930	1,050	1,175

The sight distance shown in Tables 6.18.05 and 6.18.06 are required for vehicles turning left from a public street to allow them a clear view of oncoming vehicles and complete the maneuver safely.

TABLE 6.18.05
Sight distance (ft.) for Passenger Cars Entering Private Accesses or Public Streets by Left Turns from a Public Street

Speed (mph)	Sight Distance in Feet [1]		
	2-Lane	4-Lane	6-Lane
20	165	180	195
25	205	225	240
30	245	265	290
35	285	310	335
40	325	355	385
45	365	400	430
50	405	445	480
55	445	485	530
60	490	530	575

[1] Measured from the point where a left turning vehicle stops to a vehicle approaching in the outside lane.

TABLE 6.18.06
Sight distance (ft.) for Semi-Trailers Entering Private Accesses or Public Streets by Left Turns from a Public Street

Speed (mph)	Sight Distance in Feet [1]		
	2-Lane	4-Lane	6-Lane
20	225	245	265
25	280	305	330
30	335	365	395
35	390	425	460
40	445	485	525
45	500	545	590
50	555	605	655
55	610	665	720
60	665	725	785

[1] Measured from the point where a left turning vehicle stops to a vehicle approaching in the outside lane.

The sight distances in Tables 6.18.01 and 6.18.04 apply when highway grades are zero to 3.0% (either up or down). When grades are steeper than 3.0%, adjustments must be made to compensate for the different distances required to reach the speed of highway traffic. Adjustment factors are provided in Table 6.18.07.

TABLE 6.18.07
Factors for the Effect of Grade on Sight Distance

Grade	Downgrade Factor [1]	Upgrade Factor [2]
0 - 3%	1.0	1.0
3.1 - 5%	0.7	1.3
5.1 - 8%	0.6	1.5

[1] When the highway in the section to be used for acceleration after leaving the access descends, sight distance in the direction of approaching descending highway traffic should be reduced by these factors.

[2] When the highway in the section to be used for acceleration after leaving the access ascends, then sight distance in the direction of approaching ascending should be increased by these factors.

6.19.00 ROADWAY CROWN

6.19.01 Cross Slope

Except at intersections or where superelevation is required, roadways shall be level from top of curb to top of curb (or flowline to flowline) and shall have a minimum two percent (2%) crown. Within one-hundred-fifty feet (150') of an intersection, the maximum elevation difference between flowlines shall be dictated by the allowable intersection grade and the actual distance between flowlines.

(A) Parabolic or curved crowns are not allowed. In no case shall the pavement cross slope at warped intersections exceed the grade of the through street.

(B) The rate of change in pavement cross slope when warping side streets at intersections shall not exceed one percent (1%) every twenty-five feet (25') horizontally on a local roadway, one percent (1%) every thirty-seven-and-one-half feet (37.5') horizontally on a collector roadway, or one percent (1%) every fifty-six-and-one-half feet (56.5') horizontally on arterial roadway.

(C) In the case of conflict caused by requirements of the CRITERIA, the drainage requirements shall govern.

6.19.02 Superelevation

Superelevation is required for curves on all arterial roadways and selected collector roadways. Horizontal curve radius on superelevation shall be in accordance with the recommendations of the AASHTO "A Policy on Geometric Design of Highways and Streets", latest edition (Green Book).

Superelevation shall not be used on local or other roadway classifications with a design speed of 40 miles per hour or less. The following procedure is an outline for the correct application of superelevation on roadways within the City of Westminster.

(A) Definitions Regarding Superelevation:

Superelevation Runoff. That length of roadway needed to accomplish the change in cross slope from a section with the adverse crown removed (flat) to the fully superelevated section, or vice versa.

Transition Points. Beginning or ending of tangent run-out, superelevation runoff, or full superelevation.

Tangent Run-Out. That length of roadway needed to accomplish the change in cross slope from a normal (2 percent) crown section to a section with the adverse crown removed (flat) or vice versa.

(B) General:

One of the most important factors to consider in highway safety is the centrifugal force generated when a vehicle traverses a curve. Centrifugal force increases as the velocity of the vehicle and/or the degree of curvature increases. In order to overcome the effects of centrifugal force, curves should be superelevated. It is impossible to balance centrifugal force by superelevation alone because for any given curve radius a certain superelevation rate is exactly correct for only one driving speed. At all other speeds there will be a side thrust either outward or inward, relative to the curve center, which must be offset by side friction.

(C) Standards for Superelevation:

AASHTO's Green Book, Table 3-8 on superelevation gives the required rates of superelevation for the various degree of curvature. Maximum superelevation rate of 0.04 foot per foot are commonly used on major streets.

(D) Urban Street Conditions:

Every effort should be made to maintain standard rates of superelevation. However, in urban areas street intersections, established street grades, curbs, and drainage conditions may require a reduction in the rate of superelevation or different rates for each half of the road bed. In warping areas for drainage, adverse superelevations should be avoided.

6.20.00 SIDEWALKS, CURB AND GUTTERS, RAMPS, AND DRIVEWAYS

(A) Roadway typical sections shall be as specified by these STANDARDS AND SPECIFICATIONS.

(B) Sidewalks are the portion of a street, whether paved or unpaved, between the edge of a roadway and adjacent property lines for the use of pedestrians. Sidewalks and/or shared use paths shall be constructed on both sides of all roadways and conform to ADA requirements.

(C) All sidewalks used in conjunction with vertical curb and gutter shall have a minimum width of five feet (5').

(D) State and federal law requires that accessible curb ramps be installed at all intersections and at certain mid-block locations for all new construction of curb and sidewalk [CRS 43-2-107(2) and federal Accessibility Guidelines for Public Rights-of-Way (PROWAG)]. Accessible curb ramps shall be constructed in accordance with the detail drawings in these STANDARDS AND SPECIFICATIONS. Accessible curb ramps shall be shown at all curb returns. Whenever referencing an accessible curb ramp, call out the specific detail drawing to construct that ramp. Accessible curb ramps shall be poured monolithic with the abutting curb and gutter. The ramp portion shall be constructed with cast-in-place truncated dome panels according to Section 6.75.00 of these STANDARDS AND SPECIFICATIONS. A separate curb ramp shall be provided for each marked or unmarked pedestrian street crossing. If an existing physical constraint prevents providing a separate curb ramp for each pedestrian street crossing, a single diagonal ramp shall be permitted to serve both street crossings. The use of a single diagonal ramp shall be approved by the CITY ENGINEER prior to construction.

(E) Drainage structures shall not be placed in line with accessible curb ramps. Location of accessible curb ramps shall take precedence over location of drainage structures.

(F) Medians shall be included when required by the street classification. Medians shall be paved with concrete median cover or landscaped. At intersection approaches, the median shall not be landscaped and shall be paved with concrete median cover for the distance needed to meet sight distance requirements for all allowed movements at the intersection.

(G) Concrete median cover shall meet the dimension requirements in the detail drawings.

(H) Curb cuts should not be used for commercial/industrial or high volume residential driveways. In general, when the number of parking spaces serviced by the driveway exceeds ten (10), radius returns should be used.

(I) Where curb cuts are allowed based on traffic considerations, concentrated storm water runoff must not be discharged across the sidewalk. These flows

must be directed to a sidewalk chase section. If this is not possible due to grading restraints, radius returns and a crosspan shall be used.

(J) Curb cuts and driveways shall be constructed in accordance with the detail drawings in these STANDARDS AND SPECIFICATIONS.

6.21.00 CUL-DE-SACS

The following criteria shall be used for cul-de-sac horizontal geometry.

(A) The minimum property line radius shall be fifty feet (50').

(B) The minimum flowline radius shall be forty feet (40'). See the detail drawing in this section.

(C) The maximum length of the cul-de-sac as measured along and between the radius point and the right-of-way line on the abutting street shall be five hundred feet (500') or a maximum of fifteen (15) residential dwelling units, whichever results in a shorter street. Refer to Chapter 3 and Chapter 4 of these STANDARDS AND SPECIFICATIONS for additional utility requirements that affect maximum cul-de-sac lengths.

(D) Vertical alignment shall be in accordance with Section 6.17.00 of these STANDARDS AND SPECIFICATIONS.

6.22.00 DECELERATION LANES

The design of the arterial street system depends upon the proper control of access to developments. The location and design of access points must minimize traffic hazards and interference to through traffic movements. To ensure proper control, the following standards for deceleration lanes have been established. Deceleration lanes are required if the volume of turning vehicles is 100 vehicles or more in the peak hour, as established by the approved traffic study.

(A) Requests for exemption from the requirements for a deceleration lane shall be based upon a traffic engineering study that presents trip-generation data for the proposed development in terms of impacts upon through traffic flows. Such requests shall be reviewed by the TRAFFIC ENGINEER and may be approved, except that such an approval cannot be granted if through traffic would be impeded more than three percent (3%) of the total time, more than five percent (5%) of the time during peak traffic flow periods, or if other unique circumstances warrant special design considerations.

(B) Deceleration lanes may be required along segments of collector streets if the proposed development constitutes a potential for creating a traffic hazard or unnecessarily impedes through traffic movements.

(C) Deceleration lanes shall have a minimum paved width of ten feet (10') unless otherwise approved at a lesser width by the CITY ENGINEER.

(D) The vehicle storage length of the deceleration lane shall be based upon the peak hour turning volume for the development as follows:

TABLE 6.22.01
Deceleration Lanes

Peak Hour Volume	Minimum Length
35-50	40 feet
51-60	50 feet
61-100	100 feet
101-200	175 feet
201-300	250 feet

(E) The lead-in taper length plus additional deceleration length for the deceleration lane shall be based upon the posted speed limit along the street.

TABLE 6.22.02
Deceleration Tapers

Speed Limit	Deceleration Length	Taper Ratio*
30 mph & under	160 feet	8:1
35 mph	250 feet	12:1
40 mph	370 feet	12:1
45 mph	425 feet	15:1
50 mph	500 feet	15:1

* Taper length equals taper ratio times lane width.

(F) Deceleration lanes shall be provided for all exclusive right-turn access points (i.e., right-in/right-out driveways).

(G) The deceleration lane and the associated signage and pavement marking shall be installed as per the requirements established by the TRAFFIC ENGINEER prior to the issuance of any Certificate of Occupancy within the development.

(H) Deceleration and acceleration lanes are considered part of the functional area of an intersection, as defined by AASHTO in “A Policy on Geometric Design of Highways and Streets” (Green Book). To reduce potential conflict and enhance intersection safety, driveways are not allowed within the functional area of an intersection.

6.23.00 TRANSIT AND BUS PULL-OUT LANES

Streets shall accommodate transit users.

If recommended by the Regional Transportation District or required by the CITY, bus pull-out lanes shall be designed and constructed by the adjacent subdivider.

(A) The design of the pull-out lanes shall be governed by dimensions shown in the current detail drawings from the Regional Transportation District; and shall be reviewed and approved according to procedures set forth in these design standards.

(B) The pavement design report shall consider the requirements of the pull-out lane separately from the adjacent roadway.

(C) Bus pull-outs shall be constructed with no less than fifty feet (50') between an intersection curb return curve (PC) and the beginning of the lead-in taper.

6.24.00 OFF-SITE DESIGN

(A) The design grade, and existing ground at that design grade, of all roadways that dead end due to project phasing, subdivision boundaries, etc., shall be continued in the same plan and profile as the proposed design for at least three hundred feet (300') or to its intersection with an arterial roadway.

(B) If the off-site roadway adjacent to the proposed development is not fully improved, the developer is responsible for the design and construction of a transition for the safe conveyance of traffic from the improved section to the existing roadway. The following formula shall be applied to the taper of lane change necessary for this transition:

$$L = WS^2/60$$

Where:

L = Length of Transition in Feet
W = Width of Offset in Feet
S = Speed Limit or 85th Percentile Speed

(C) The CITY ENGINEER should be contacted to establish unusual transition criteria. This contact is the responsibility of the applicant.

6.30.00 PAVEMENT DESIGN AND TECHNICAL CRITERIA

6.31.00 GENERAL

This section provides the basic criteria and design procedures for roadway pavements. Recommended design methodologies for asphalt and Portland cement concrete are addressed and essentially follow the Colorado Department of Transportation methodology. Some standardization of criteria has been made in design procedures.

For all CITY roadway construction, the applicant shall provide a subgrade investigation and pavement design report that recommends typical pavement structural section based on the known site soil conditions and the valid traffic study. This pavement design serves as a justification of the roadway improvements agreement in addition to determining roadway structural requirements.

6.32.00 SUBGRADE INVESTIGATION

All subgrade investigation shall be in accordance with these STANDARDS AND SPECIFICATIONS, and more specifically:

(A) The field investigation shall consist of borings or other suitable methods of sampling subgrade soils to a depth of at least three feet (3') below proposed subgrade elevation at spacings of not more than two hundred fifty feet (250') unless otherwise accepted by the CITY ENGINEER. Samples shall be taken after grading is completed and the subgrade is rough cut.

(B) The treatment of expansive soils shall be in accordance with these STANDARDS AND SPECIFICATIONS unless approved otherwise, in writing, by the CITY ENGINEER.

(C) The "Subgrade Resilient Modulus" (Mg) shall be correlated the Resistance Value (R-value) using the formulas in these STANDARDS AND SPECIFICATIONS. If the Plasticity Index (PI) of the subgrade is more than 15 or the R-value of the soil is less than 10, then the subgrade shall be stabilized with one of the methods outlined in these STANDARDS AND SPECIFICATIONS.

6.33.00 PAVEMENT DESIGN CRITERIA

6.33.01 General

This section provides the parametric input data to be used for the design of pavements of various roadway classifications.

6.33.02 Equivalent (18 Kip) Single Axle Load Applications (ESAL)

The pavement design procedure in this section provides for a 20-year service life of pavement, given that normal maintenance is provided to keep roadway surface in an acceptable condition. ESAL and Design Traffic Number (DTN) are considered equivalent units based on 20-year design criteria and an 18 Kip axle loading. All data and design nomographs in this chapter use ESAL units for pavement loading repetitions. Minimum ESAL criteria for each roadway classification are given in Table 6.33.02 and are to be used when a traffic study indicates lesser ESAL values.

TABLE 6.33.02
Minimum Equivalent (18 Kip) Single Axle Load Applications (ESAL)

Classification	Class Modifier	ESAL Values
Cul-de-Sac	Serving <10 D.U.	14,6000
Local	Serving <80 D.U.	36,000
Minor Collector	Residential	219,000
	Commercial	365,000
Major Collector	All	730,000
Minor Arterial	All	1,460,000
Major Arterial	All	1,460,000

(1) ESAL for major arterial roadways shall be set on a case-by-case basis; 1,460,000 is the recommended minimum for planning purposes.

6.33.03 Design Serviceability Loss (APSI)

The following criteria shall be used for all CITY roadways to be dedicated for public use: ASI is based on an initial serviceability index of 4.5 and is the value to use in the CDOT procedure.

TABLE 6.33.03
Serviceability Index and Loss

Roadway Classification	SI	ASI
Arterials (Minor, Major)	2.5	2.0
Collectors:		
Major	2.5	2.0
Minor Commercial	2.5	2.0
Minor Residential	2.5	2.0
Local and Private Parking Lots	2.0	2.5

6.33.04 Reliability

Reliability is the probability that the pavement system will perform its intended function over its design life (or time) and under the conditions (or environment) encountered during operation.

TABLE 6.33.04
Reliability (Risk)

Functional Classification	Reliability
Principal Arterials	95
Minor Arterials	95
Collectors	90
Local	80

6.33.05 Minimum Pavement Section

This paragraph provides the minimum acceptable pavement sections for public roadways in the CITY. The pavement thickness may be used for preliminary planning purposes. Final pavement designs shall be based on actual subgrade support test results. Table 6.33.05 lists the minimum thickness for each roadway classification.

TABLE 6.33.05
Minimum Pavement Sections

Classification	Composite (3) Asphalt Inches	Section Treated Subgrade	Full Depth (2) Asphalt Inches
Cul-de-sac (1)	--	--	6.0
Local	4	8	5.0
Minor Collector			
(A) Residential	4	8	7.0
(B) Commercial	4	8	7.0
Major Collector	4	8	7.0
Minor Collector	5	8	7.0
Major Arterial	6	8	9.0

(1) All cul-de-sacs shall be the minimum full depth shown or the full depth determined by the subgrade support tests, whichever is greater.

(2) "Full Depth Asphalt" is required in all RIGHT-OF-WAY.

(3) Composite sections will only be allowed on private streets and private parking lots.

6.33.06 Flexible Pavement Strength Coefficients

Table 6.33.06 contains the standard design coefficients for various pavement materials. Non-standard design coefficients may be used only if approved in advance by the CITY ENGINEER. In addition, design values shall be verified by predesign mix test data and supported by daily construction tests or redesign values shall be required; i.e., such as add one-half inch (1/2") to one inch (1") to the in-place surface course of final asphalt concrete.

TABLE 6.33.06
Strength Coefficients

Pavement Structure Component*	Structural Layer Coefficients	(Limiting Test Criteria)
Conventional Materials:		
Hot Bituminous Pavement	0.44	
Exist Bituminous Pavement	0.30	(9-15 yr)
	0.24	(> 15 yr)
Aggregate Base Course	0.14	(R-value ≥ 83)
Aggregate Base Course	0.12	(77 ≤ R-value < 83)
Aggregate Base Course	0.11	(69 ≤ R-value < 77)
Aggregate Base Course	0.10	(R-value < 69)
Treated Materials:		
Cement-Treated Aggregate Base	Refer to the Pavement Design Report accepted by the CITY	
Lime-Treated Subgrade	Refer to the Pavement Design Report accepted by the CITY	

*The combination or one or more of the following courses placed on a subgrade to support the traffic loading and distribute it to the road bed.

(A) Subbase. The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course, surface course, or both.

(B) Base Course. The layer or layers of specified or selected material of designed thickness placed on a subbase or a subgrade to support a surface course.

(C) Surface Course. One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is sometimes called "wearing course."

6.34.00 PAVEMENT DESIGN PROCEDURE

6.34.01 Flexible Pavements

(A) The following procedure should be used in determining the structural number (SN) of the pavement being designed.

1. Determine roadway classification and corresponding ESAL (Traffic Study or Table 6.33.02 whichever is greater).

2. Determine the serviceability loss (ASI) of the roadway classification (Table 6.33.03).

3. M_R value of subgrade as determined by soils report from laboratory and/or correlation equation below:

   Convert Hveem "R" to Soil Support

   $S_1 = [(\text{"R"} - 5)/11.29] + 3$

   To Convert S_1 to M_R

   $[S_1 + 18.72]/6.24$

   $M_R = 10$

4. Structural Layer Coefficients (Table 6.33.06)

5. Overall deviation, So, which is 0.44 for flexible pavement.

6. Reliability, R, (see Table 6.33.04)

7. Use nomograph (Table 6.34.01) or use the AASHTO pavement design software, DARWin™ to obtain the Structural Number (SN).

8. Once the structural number (SN) has been determined, the design thicknesses of the pavement structure can be determined by the general equation:

$SN = a_1 D_1 + a_2 D_2 + a_3 D_3 + \ldots$

Where:

a_1 = Hot Bituminous Pavement (HBP) strength coefficients

D_1 - Thickness of Hot Bituminous Pavement (HBP) (inches)

D_2, D_3, D_n - Thickness of Additional Pavement Component Sections (inches)

a_2, a_3, a_n - Strength coefficient for the corresponding pavement structure*

*The Strength coefficients for various components of the pavement structure are given in Table 6.33.06. The component thickness selected must meet two conditions:

a. Total HBP thickness selected cannot be less than the minimum specified in Table 6.33.05 for the roadway classification.

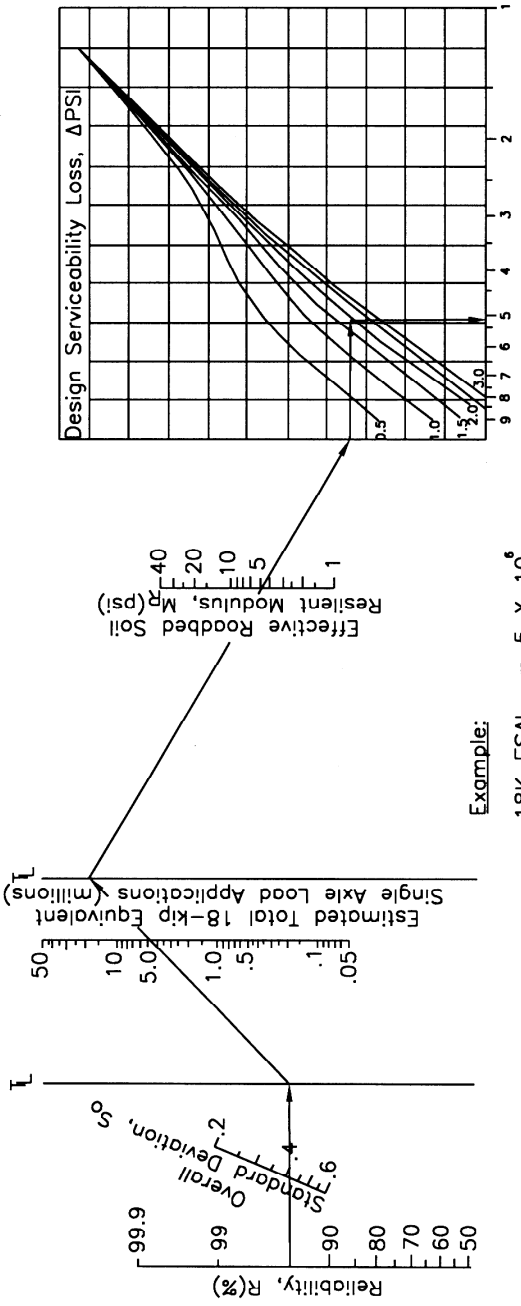
b. The base course thickness cannot exceed 2.5 times the HBP thickness selected. If a base course section is allowed, in writing, by the CITY ENGINEER.

TABLE 6.34.01

Flexible Pavement Design

NOMOGRAPH SOLVES:

$$\log_{10}18^{K}ESAL = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10}M_R - 8.07$$



Example:

18K ESAL = 5 X 10^6

R = 95%

S_o = 0.44

M = 5000 psi

ΔPSI = 2.0

Solution: SN = 5.1

6.34.02 Rigid Pavement

If rigid pavement is allowed by the CITY ENGINEER, the procedures provided by the CITY shall be followed.

6.35.00 SUBGRADE INVESTIGATION AND PAVEMENT DESIGN REPORT

The report shall be prepared by or under the supervision of and signed and sealed by a Professional Engineer registered in the State of Colorado and shall include the following information:

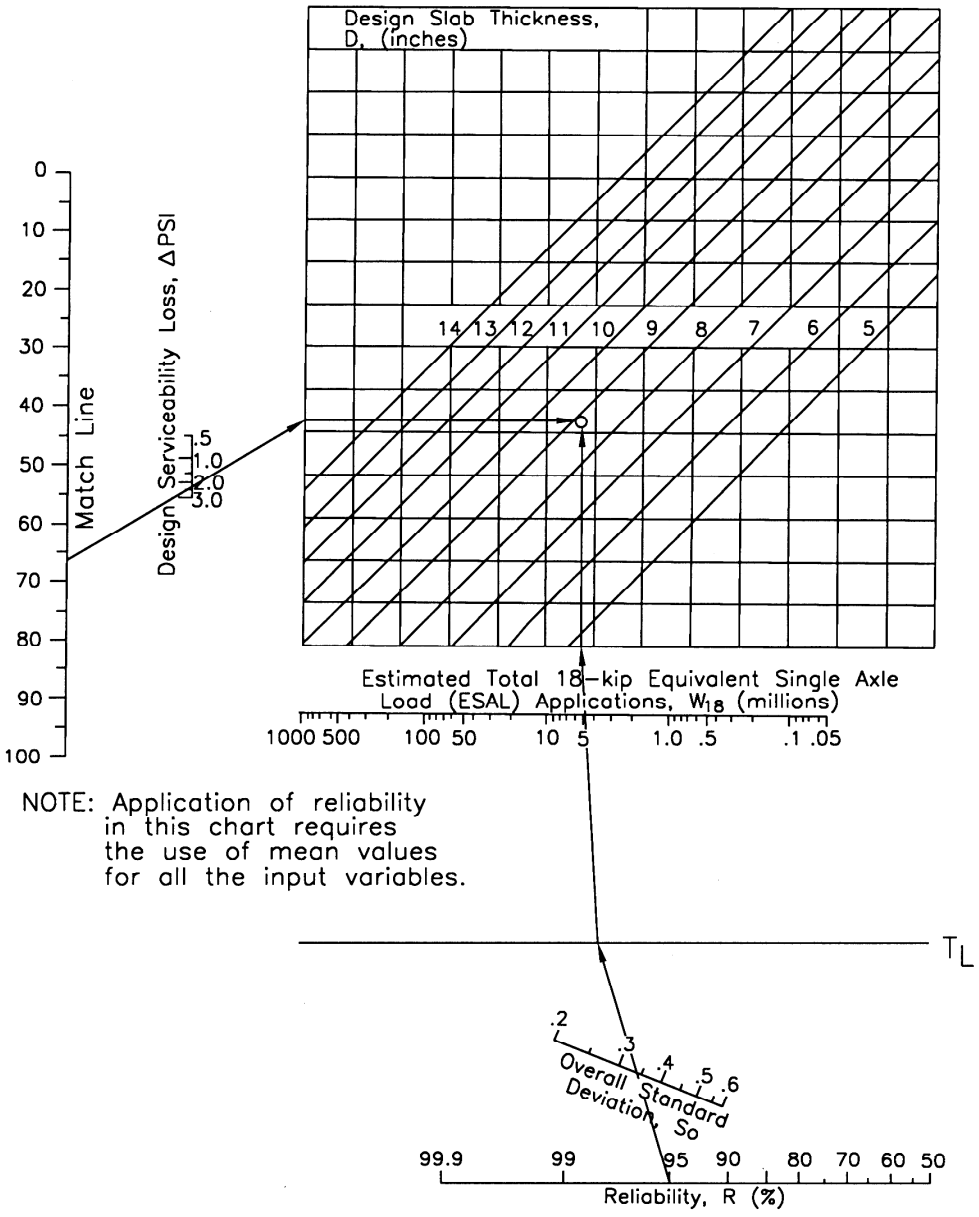
(A) Vicinity map to locate the investigated area.

(B) Scaled drawings showing the location of borings.

(C) Scaled drawings showing the estimated extent of subgrade soil types and EDLA for each street.

TABLE 6.34.02

Rigid Pavement 2 of 2



Design chart for rigid pavements based on using mean values for each input variable (Segment 2).

(D) Pavement design alternatives for each street on a scaled drawing.

(E) Tabular listing of sample designation, sample depth, group number, liquid limit, plasticity index, percent passing the No. 200 sieve, AASHTO classification, group index, and soil description.

(F) CBR (R-value) test results of each soil type used in the design.

(G) Pavement design nomographs properly drawn to show soil support -- ESAL - SN.

(H) Design calculations.

(I) A discussion regarding potential subgrade soil problems including, but not limited to:

1. Heave or settlement-prone soil.

2. Frost-susceptible soils.

3. Ground water.

4. Drainage considerations (surface and subsurface).

5. Cold-weather construction (if appropriate).

6. Other factors or properties which could affect the design or performance of the pavement system.

(J) Recommendations to alleviate or mitigate the problems discussed in Items 1 through 6 above.

6.40.00 CONSTRUCTION SPECIFICATIONS

6.41.00 GENERAL

The purpose of this section is to set forth the criteria to be used in the construction of all streets and appurtenances within the CITY.

6.42.00 COMPACTION IN UTILITY TRENCHES

Before new street construction will be permitted, all utility trenches within the street right-of-way (including service lines) shall be compacted to ninety-five percent (95%) of maximum standard density, as determined by ASTM D 698 or as specified in the approved soils report. This compaction shall extend to the street right-of-way lines as a minimum. Water settlement of trenches shall not be permitted. All water and sewer services, including water and sewer main stub-outs, shall be installed prior to street

construction except that curb and gutter and sidewalk shall be installed prior to water service line installation, unless otherwise directed by the CITY ENGINEER.

6.43.00 EXCAVATION AND EMBANKMENT

6.43.01 General

The intent of this section is to specify methods and standards to be used in the construction of embankments or excavations for CITY streets or for other purposes, as indicated on the approved drawings or contract documents. The work will include excavation, embankment, grading; compacting; clearing and grubbing; removal of topsoil, trees, stumps, or other vegetation; removal and/or resetting of minor obstructions; subgrade preparations; and any other work incidental for the construction of excavations and embankments. All workmanship and materials shall be in accordance with the requirements of these STANDARDS AND SPECIFICATIONS and in conformity with the lines, grades, quantities, and the typical cross-section shown on the plans or as directed by the CITY ENGINEER.

6.43.02 Clearing and Grubbing

Work shall consist of clearing, grubbing, removing and disposing of all vegetation and debris within the limits of the project, and such other areas as may be indicated on the approved plans or required by the work except such objects as are designated to remain or are to be removed in accordance with other sections of these STANDARDS AND SPECIFICATIONS. All surface objects and trees, stumps, roots, and other protruding obstructions not designated to remain shall be cleared and/or grubbed as required except non-perishable solid objects which shall be a minimum of two feet (2') below subgrade.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted in accordance with these STANDARDS AND SPECIFICATIONS. Materials and debris shall be disposed of in a manner acceptable to the CITY ENGINEER. Burning shall not be permitted.

The CONTRACTOR shall make all necessary arrangements for obtaining suitable disposal locations. If disposal will be at other than established dump sites, the CITY ENGINEER shall require the CONTRACTOR to furnish written permission from the property owner on whose property the materials and debris will be placed. Branches on trees or shrubs shall be removed as directed. Branches of trees extending over the road bed shall be trimmed to give a clear height of twenty feet (20') above the road bed surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

6.43.03 Removal of Existing Structures

(A) The CONTRACTOR shall raze, remove, and dispose of all foundations, signs, structures, fences, old pavements, abandoned pipelines, traffic signal materials, and other obstructions which are within the project limits except for utilities and for those items which other provisions have been made for removal. Traffic signals and related materials will include all attachment hardware and other incidental materials such as, but not limited to, mast arms and span wire. Concrete adhering to sign posts shall be removed, and pedestals and bases shall be removed to two feet (2') below the surrounding ground or subgrade.

Where portions of structures are to be removed, the remaining portions shall be prepared to fit new construction. The work shall be done in accordance with plan details and in such a manner that materials to be left in place will be protected from damage. All damage to portions of structures which are to remain in place shall be repaired by the CONTRACTOR at their expense. Reinforcing steel, projecting from the remaining structure, shall be cleaned and aligned to provide bond with new extension. Dowels shall be securely grouted with approved grout. All other removals are subject to review process by the CITY.

(B) Bridges, culverts, and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic. Unless otherwise directed, the substructures of existing structures shall be removed to one foot (1') below natural stream bottom or ground surface. Where such portions of existing structures lie wholly or in part within the limits of a new structure, it shall be removed as necessary to accommodate the construction of the proposed structure. Steel, precast concrete, and wood bridges shall be carefully dismantled without unnecessary damage. Steel members to be salvaged shall be match-marked with waterproof paint.

(C) Unless otherwise provided, all pipe shall be carefully removed and cleaned. Every precaution shall be taken to avoid breaking or damaging the pipe. Pipes to be relaid shall be removed and stored, when necessary, so that there will be no loss or damage before relaying. When removing manholes, catch basins, and inlets, any live sewer connected to these items shall be properly reconnected and satisfactory bypass service shall be maintained during such operation.

(D) Concrete or asphalt concrete that is to remain shall be cut in a straight, true line with a vertical face. The CONTRACTOR shall be responsible for the cost of removal and replacement of all overbreak. Sawing shall be done carefully, and all damages to concrete or asphalt to remain in place, which are caused by the CONTRACTOR's operations, shall be repaired by the CONTRACTOR at their expense. The minimum depth of saw cuts in concrete shall be two inches (2"). If the removed portion falls within five

feet (5') of an existing joint or edge, the concrete shall be removed to that joint or edge.

6.43.04 Salvage

All salvageable material shown on the plans shall be removed without unnecessary damage in sections or pieces which may be readily transported and shall be stored by the CONTRACTOR in locations approved by the CITY ENGINEER. The CONTRACTOR shall be required to replace any materials lost from improper storage methods or damaged by negligence.

6.43.05 Disposal

The CONTRACTOR shall make all necessary arrangements for obtaining suitable disposal locations, and the cost involved shall be included in the work. If disposal will be at other than established dump sites, the CITY ENGINEER may require the CONTRACTOR to furnish written permission from the property owner on whose property the materials will be placed.

6.43.06 Excavation and Embankment

Excavation of whatever substances that are encountered within the limits of the project shall be performed to the lines and grades indicated on approved plans. All excavated areas shall be graded in a manner that will permit adequate drainage. Whenever practicable, all suitable material removed from the excavations shall be used in the formation of embankments, for backfilling, and for other approved purposes. Where material encountered within the limits of the work is considered unsuitable, such material shall be excavated below the grade shown on the approved drawings or as directed by the CITY ENGINEER and replaced with suitable material. All unsuitable excavated materials and any surplus or excavated material which is not required for embankments shall be disposed of by the CONTRACTOR.

Before any embankment is placed, clearing, tree removal, sod and topsoil removal over the entire area shall be performed in accordance with these STANDARDS AND SPECIFICATIONS. The base of fill areas shall be scarified to a depth of not less than six inches (6") prior to placement of embankment material. Each layer shall be wetted or aerated, if necessary. No embankment material shall be placed upon organic, spongy, or frozen material or other material unsuitable for the placement thereof in the opinion of the CITY ENGINEER. When an embankment is to be placed on slopes, it shall be continuously benched in horizontal layers to key to the existing slopes.

The construction of embankments by deposition, placing, and compacting materials of acceptable quality above the natural ground or other surface shall be in accordance with the lines, grades, and cross-sections shown on the approved plans and/or as required by the CITY ENGINEER. Each lift of the embankment material shall not exceed eight inches (8") in loose depth. The

CONTRACTOR shall thoroughly mix the different materials to secure a uniform moisture content and to insure uniform density and proper compaction. Each layer shall be thoroughly compacted by roller or vibratory equipment which is suitable for the type of embankment material to 95% of maximum dry density unless otherwise prescribed in an approved geotechnical report recommendation or directed by the CITY ENGINEER.

Class I structural backfill shall be used on all bridges, box culverts, or where otherwise specified. All other backfill shall be developed on site.

6.43.07 Select Borrow Material

In the event the material found on site is unsatisfactory for constructing subgrade, embankments, or filling excavations, the CONTRACTOR shall provide material from off-site. The selected borrow material shall be a well-graded mixture of sound mineral aggregate particles containing sufficient quality bonding material to secure a firm stable foundation when placed and compacted on the roadway. The R-value of the borrow shall be equal to or greater than the design R-value required for the street. The R-value of the borrow shall be provided to the CITY ENGINEER prior to placing borrow. If tests reveal that material being placed is not of suitable quality and structural value, the CONTRACTOR shall provide other material as approved by the CITY ENGINEER.

6.44.00 SUBGRADE PREPARATION AND GRADING

6.44.01 General

The work covered by this section concerns the furnishing of all labor, equipment, supplies, and materials needed to perform preparation of subgrade within the public RIGHT-OF-WAY. The bottom of the excavation for the pavement, or top of the fill, will be known as the pavement subgrade and shall conform to the lines, grades, and cross-sections shown on the approved plans. Prior to the street being excavated, all service cuts shall be checked to see if the backfill meets density requirements. If deficient, they shall be recompacted and brought up to the density as specified in Chapter 9 of these STANDARDS AND SPECIFICATIONS.

6.44.02 Subgrade Stabilization

Embankment and subgrade soils shall be compacted to ninety-five percent (95%) of maximum standard density at plus or minus two percent (±2%) optimum moisture or as recommended in the approved soils report. Maximum density shall be determined by ASTM D 698. Soft and yielding material and other portions of the subgrade which will not compact when rolled or tamped shall be removed as directed by the CITY ENGINEER and replaced with suitable material.

Subgrade surfaces below excavated areas such as cut areas and undisturbed areas shall require additional preparation. Said subgrade shall be scarified to a minimum depth of twelve inches (12"), wetted or aerated as needed, and compacted until the required density is obtained, unless otherwise approved by the CITY ENGINEER. No paving, subbase, or base shall be placed on soft, spongy, or frozen unstable subgrade which is considered unsuitable by the CITY INSPECTOR.

The CONTRACTOR shall furnish the necessary equipment to proof roll, even though density tests may indicate compliance. Minimum 5000 gallon loaded water truck or other trucks approved by the CITY INSPECTOR shall be driven over the finished subgrade and deflections noted. Soft and yielding material and portions of the subgrade which show deflection shall be scarified and re-rolled or shall be removed and replaced with subgrade course material and then placed and compacted as specified herein. Subgrade shall not be approved for base course construction or paving until it is uniformly stable and unyielding.

6.44.03 Chemically Treated Subgrade

When recommended by the approved soils report and/or pavement design, the surface of the road bed shall be bladed to the established lines, grades, and cross-sections as shown on the approved plans. The prepared road bed shall be scarified to the depth and width required for the subgrade stabilization. The material thus obtained shall be pulverized. Application, mixing, and finishing shall be in accordance with CDOT Standard Specifications for Road and Bridge Construction (latest revision), Section 307. Lime shall conform to the requirements of ASTM C 977 and rate of slaking test for moderate reactivity per ASTM C 110 and shall be the product of a high-calcium limestone as defined in by ASTM C 51.

6.44.04 Mechanically Treated Subgrade

Means of mechanically treating subgrade, including but not limited to geogrid, will be considered based on review of a geotechnical design report.

6.44.05 Subgrade Surface Tolerance

The excavation and embankments for the street, intersections, and driveways shall be finished to a reasonably smooth and uniform surface. Variations from the subgrade shall not be more than one-half inch (1/2") in soil nor more than one inch (1") above or six inches (6") below in rock.

6.45.00 SUBBASE CONSTRUCTION

6.45.01 General

The subbase shall consist of a foundation course composed of granular material constructed on the prepared subgrade in accordance with these STANDARDS AND SPECIFICATIONS and in reasonable conformity to the lines and grades and typical cross-sections as shown on the approved plans.

6.45.02 Placement and Compaction

Each layer of subbase material shall be placed in layers not to exceed six inches (6") in compacted depth. Each layer shall be wetted or aerated, if necessary, and compacted to ninety-five percent (95%) maximum density at plus or minus two percent (±2%) of optimum moisture as determined by ASTM D 698. No subbase material shall be placed upon a soft, spongy, or frozen subgrade or other subgrade, the stability of which is unsuitable for the placement thereof.

6.45.03 Subbase Surface Tolerance

The prepared surface of the subbase shall not vary from the approved grade by more than a half inch (1/2").

6.46.00 BASE CONSTRUCTION

6.46.01 General

The intent of this section is to specify methods to be used for the construction of private roads and private parking lots requiring the use of aggregates. The work covered shall include general requirements that are applicable to aggregate base course, asphalt base, and pavements of the plant-mix type, prime coat, tack coat, rejuvenating applications, and asphalt concrete overly. All workmanship and material shall be in accordance with requirements of these STANDARDS AND SPECIFICATIONS and in conformity with the lines, grades, depths, quantity requirements, and the typical cross-section shown on the approved plans or as directed by the CITY ENGINEER.

6.46.02 Base Course

This item shall consist of a foundation course composed of crushed gravel or crushed stone and filler, constructed on the prepared subgrade or subbase course. Construction shall be in accordance with the requirements of the CDOT's Standard Specifications for Road and Bridge Construction, Section 304 and the approved pavement design. The composite base course material shall be free from vegetation and lumps or balls of clay.

6.46.03 Placement and Compaction

The base course material shall be deposited and spread in a uniform layer without segregation of size to a compacted depth not to exceed six inches (6"). The material shall be compacted to a minimum ninety-five percent (95%) density as determined by ASTM D 698. No base course material shall be placed upon a soft, spongy, or frozen subgrade or subbase with an unsuitable stability. Base material shall not be placed on a dry or dusty foundation where the existing condition would cause rapid dissipation of moisture from the base material and hinder or preclude its proper compaction. Such dry foundations shall have water applied and shall be reworked and recompacted.

Rolling shall be continuous until the base material has been compacted thoroughly in accordance with these STANDARDS AND SPECIFICATIONS. Water shall be uniformly applied as needed during compaction to obtain optimum moisture content and to aid in consolidation. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture is produced and the aggregates are firmly placed.

6.46.04 Base Surface Tolerance

The prepared surface of the base shall not vary from the approved grade by more than one-half inch (1/2").

6.47.00 HOT MIX ASPHALT CONSTRUCTION

6.47.01 Hot Mix Asphalt Pavement

All pavement shall be hot mix asphalt pavement of the plant mix type unless otherwise approved in writing by the CITY ENGINEER. Construction shall be in accordance with Chapter 6 of these STANDARDS AND SPECIFICATIONS.

6.47.02 Tack Coat

When tack coat is specified on the approved plans or required by the CITY ENGINEER, all construction shall be in accordance with the requirements of Chapter 6 of these STANDARDS AND SPECIFICATIONS.

6.47.03 Grinding

(A) Grinding shall consist of milling, grinding, or cold planing the existing pavement surface to establish a new surface profile and cross section in preparation for an asphalt overlay. It shall consist of furnishing all equipment, supervision, labor, and necessary items for removal and disposal of pavements and pavement markings as illustrated in the plans or as directed. It shall also include salvaging and hauling away all planed

material, and sawing and cutting to facilitate controlled breaking and removal of concrete and asphalt pavement to a neat line.

(B) The CONTRACTOR shall supply all equipment necessary to perform the work, including but not limited to: A planer with sufficient power, traction, and stability shall be required to maintain an accurate depth of cut. The propulsion and guidance system of the planer shall be maintained in such condition that the planer may be operated to straight and true lines without excessive lateral deviation. Operation with broken or missing teeth will not be allowed. Worn teeth shall be replaced if the planer does not produce a uniform surface. The planer shall be capable of picking up the removed asphalt cement concrete pavement in a single operation. A self-loading conveyer shall be an integral part of the planer. Windrows will not be allowed. A sufficient number of brooms shall be used immediately after planing to remove all planed material remaining on the roadway. All equipment and machinery shall be kept in good working order, free of leaks and properly muffled.

(C) Prior to beginning planing operations, the CONTRACTOR shall submit a planing plan for approval by the CITY ENGINEER. This plan shall include as a minimum:

- The number and types of planers to be used.
- The width and location of each planing pass.
- The number and types of brooms to be used, and their locations with respect to the planers. The CONTRACTOR shall have at least one back-up broom on the project at all times in case one of the operating brooms breaks down.
- Traffic control plan.
- Pedestrian access plan including how vertical face of milled edges at crosswalks will be addressed.
- Considerations for how material will be prevented from entering drainage inlets, by covering or other means, during milling and paving operations.

(D) When planing adjacent to new asphalt pavement, the planer shall cut a minimum of 3 inches laterally into the new asphalt pavement. The asphalt pavement shall be broken or chipped away to match the plane depth. The planed surface shall be no rougher (in inches/mile) than the original surface.

(E) When planing operations and the CONTRACTOR's phasing cause rough or uneven surface conditions for traffic, appropriate signage shall be placed, including but not limited to: Bump, Grooved Pavement, Uneven Lanes, and Shoulder Drop Off signs.

(F) Traffic crossing vertical faces at the edges of milled pavement will not be allowed. Longitudinal milled faces shall be tapered to not less than a 3:1 slope. Transverse vertical faces shall be tapered to not less than a 25:1 slope. The use of temporary asphalt wedges with a papered joint for transverse tapers is allowed.

6.47.04 Infrared Patching

(A) When specified by the CITY ENGINEER, the roadway surface shall be repaired by the infrared method. The repairs shall include the cleaning of the area, infrared heating, adding specified asphalt material, raking to grade and compacting with approved compaction equipment. All work shall be done in accordance with these STANDARDS AND SPECIFICATIONS and as directed by the CITY ENGINEER.

(B) The CONTRACTOR performing this work must be fully qualified and properly equipped to complete this work expeditiously and in a satisfactory manner.

(C) The CONTRACTOR shall furnish equipment meeting the following: The unit can either be truck or trailer mounted. Each unit shall have the following equipment:

i. Heated storage unit.

ii. Reflective chamber that is fully vented and painted with a highly reflective paint.

iii. Equipped with all CDOT safety devices.

(D) All infrared asphalt repair material must contain 50% crushed fines and 50% natural sand fines with an asphalt content of no less than 6.5%. Variations of these requirements can be accepted on a pavement design report submitted to and approved by the CITY ENGINEER. All material must be stored and obtained from a suitable infrared heated storage unit required to keep asphalt at near constant temperature throughout the day. Under no circumstances is any asphalt mix to be used that is at a temperature less than 200 ˚F.

(E) The work shall be performed in the following general manner:

i. Areas to be repaired shall be swept clean to remove all lose and foreign material.

ii. An approved infrared heater not to exceed fifteen thousand British Thermal Units (15,000 BTUs) per square foot per hour shall be positioned over the area to be repaired for a period of time required to soften the existing pavement to a depth of two to three inches (2" to 3"). If a depth of more than three inches (3") is required, multiple heatings and removals will be required.

iii. Oxidation of the pavement, caused by excessive heat as determined by the CITY INSPECTOR, shall be avoided. In the event of oxidation, the CONTRACTOR shall remove the unsuitable material and replace with approved asphalt material.

iv. The soft material shall be removed a minimum of six inches (6") from the heated edge to ensure no cold joint will exist. It is not acceptable to remove the entire heated area. A straight edge shall be cut with a rake for cosmetic appearance, with corners at ninety degrees (90°). Approved asphalt stated above shall be added to the heated surface and shall be raked to a workable condition and compacted in maximum three inch (3") lifts.

v. After the paving mixture has been admixed and raked to grade, compaction shall be obtained by use of a steel wheeled vibratory roller of at least two tons to establish uniform density to ninety-four percent plus-minus two percent (94% ±2%) theoretical maximum density. The finished patch shall be level with no depression retaining water on any of its surface.

6.48.00 PORTLAND CEMENT CONCRETE PAVEMENT

Portland Cement Concrete Pavement is not allowed in RIGHT-OF-WAY. Concrete pavement may be allowed in private alleys, but if public utilities are to be under the private alley then the concrete pavement must conform with the pavement design report and be approved in writing by the CITY ENGINEER.

6.49.00 APPURTENANT CONCRETE STRUCTURES

6.49.01 Curb and Gutter Section

The section to be constructed shall be as identified on the approved plans or as shown on the detail drawings.

6.49.02 Sidewalks and Trails

Sidewalks shall be six inches (6") thick and detached or six inches (6") thick and attached and constructed to the dimensions shown on the approved construction plans. All areas of sidewalk that will be crossed by driveways will be constructed with six-inch (6") thick concrete in residential areas and eight-inch (8") thick concrete in commercial areas.

6.49.03 Crosspans and Curb Return Fillets

Crosspans and curb return fillets shall be constructed eight inches (8") thick with fiber mesh reinforced concrete. Typical crosspan sections are shown on the detail drawings. Where unusual conditions prevail, additional reinforcing steel and special joints may be required by the CITY ENGINEER.

6.49.04 Curb Cuts and Driveways

Curb cuts shall be provided at all driveway locations and at additional locations, as shown on the approved plans. Construction of curb cuts shall be as shown on the detail drawings and meet Americans With Disabilities Act requirements. Spacing will be as shown on the approved plans or as approved by the TRAFFIC ENGINEER.

6.49.05 Curb Ramps

Curb ramps for accessibility shall be installed at locations designated by the TRAFFIC ENGINEER. Curb ramps will be constructed as shown on the detail drawings.

6.49.06 Detectable Warning Tiles

(A) The CONTRACTOR will not be allowed to install cast-in-place detectable warning tiles until all submittals have been reviewed and approved by the CITY ENGINEER. Cast-in-place tile shall be installed per manufacturer's instructions. Protect the cast-in-place tiles against damage during the construction period to comply with cast-in-place tiles manufacturer's specifications.

(B) The CONTRACTOR shall provide all tools, equipment and services required for satisfactory installation per manufacturer's instructions. Equipment which may be required include typical mason's tools, a four-foot (4') long level with electronic slope readout, twenty-five (25) pound weights, vibrator and rubber mallet with two-inch by four-inch by ten-inch (2" x 4" x 10") wood tamping plate, and a device for cutting the cast-in-place tile.

(C) The CONTRACTOR shall engage an experienced installer certified in writing by the cast-in-place tile manufacturer, who has successfully completed Tactile Warning Surface installations similar in material, design, and extent to that indicated by the detail and/or construction drawings.

(D) The physical characteristics of the concrete shall be consistent with these STANDARDS AND SPECIFICATIONS while maintaining a slump

range of four to seven inches (4" – 7") to permit solid placement of the cast-in-place tile. An overly wet mix will cause the cast-in-place tile to float. Under these conditions suitable weights such as two (2) concrete blocks or sandbags weighing approximately twenty-five (25) pounds shall be placed on each cast-in-place tile.

(E) The concrete shall be poured and finished, true and smooth to the required dimensions and slope prior to the cast-in-place tile placement.

(F) To the maximum extent possible, the cast-in-place tiles shall be oriented such that the rows of in-line truncated domes are parallel with the direction of the ramp. When multiple cast-in-place tiles regardless of size are used, the truncated domes shall be aligned between the tactile warning surface tiles and throughout the entire tactile warning surface installation.

(G) Cast-in-place tiles shall be tamped or vibrated into the fresh concrete to ensure that there are no voids or air pockets, and the field level of the cast-in-place tile is flush to the adjacent concrete surface or as the detail drawings indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

(H) Cutting and setting of cast-in-place tiles shall be cut into the size and configuration indicated on the detail drawings using a sixty (60) tooth carbide blade on a table saw or equivalent cutting device. Minimize any cantilever effect (to the maximum extent practicable) when cutting between successive embedment ribs as concrete will tend to flow up and over the cast-in-place tiles. The top of the body of the cast-in-place tiles shall be fully seated and flush with the adjacent concrete substrate. For specific instructions for cutting and setting refer to Tactile Warning Surface manufacturer's written instructions.

(I) During and after the cast-in-place tiles installation and the concrete curing stage, there shall be no walking, leaning or external forces placed on the cast-in-place tiles to rock the cast-in-place tile, causing a void between the underside of the cast-in-place tile and the concrete.

(J) Remove Protective Plastic Sheeting from cast-in-place tile within twenty-four (24) hours of installation of the cast-in-place tile. Particularly under hot weather conditions (80 degrees or higher), plastic sheeting will adhere strongly to Tactile Warning Surface Tile when not removed quickly resulting in difficult removal.

(K) If requested by the CITY ENGINEER, clean cast-in-place tiles not more than four (4) days prior to date scheduled for inspection intended to

establish date of substantial completion in each area of project. Clean cast-in-place tile by method specified by Tactile Warning Surface Products manufacturer.

6.49.07 Construction Stakes

The CONTRACTOR's surveyor shall provide all stakes required for curbs, gutters, walks, and structures and shall furnish all necessary information relating to lines and grades. The CONTRACTOR shall be held responsible for the reasonable preservation of all such stakes.

6.49.08 Backfilling

When side forms are removed, the space adjoining the concrete shall be backfilled in a timely manner with suitable material properly compacted and brought flush with the surface of the concrete and adjoining ground surface. In embankments, the backfill shall be level with the top of the concrete for at least two feet (2') and then sloped to the property line. Maximum slope shall be four to one (4:1). Where detached walks occur, the space between the curb and walk shall be backfilled on a straight line from the top of walk to the top of curb.

6.49.09 Connections with Existing Concrete Curb, Gutter, Inlets, Sidewalk, and Drives

Where new construction abuts existing, the work shall be accomplished so that no abrupt change in grade between the old and new work results. New concrete construction shall be mechanically connected to existing concrete features by means of dowels or other approved method.

6.50.00 BRIDGES AND MAJOR DRAINAGE STRUCTURES

6.50.01 General

(A) All culvert pipe, box culverts, and bridges which will ultimately be maintained by the CITY shall conform to the following:

1. AASHTO "Standard Specifications for Highway Bridges," latest edition, and applicable interims.

2. CDOT's "Standard Specifications for Road and Bridge Construction," latest edition.

3. CDOT's "Bridge Manual," Volumes I and II.

(B) All structures shall be designed to an HL-93 loading.

(C) All box culvert and bridge designs shall be stamped by a Professional Engineer registered in the State of Colorado who is competent to perform such designs.

6.51.00 CRUSHER FINES TRAILS

6.51.01 General

This work consists of construction of trails or shared use paths surfaced with crusher fines. Crusher fines materials shall be according to the requirements contained in these STANDARDS AND SPECIFICATIONS.

6.51.02 Equipment

(A) Equipment shall be capable of performing the work as described in this specification. Equipment that is inadequate to obtain the results specified shall be replaced or supplemented as required to meet the requirements of this specification. Any equipment that is used in an improper manner may be cause for rejection of the work if in the opinion of the CITY ENGINEER the work fails to meet the requirements of this specification.

(B) Equipment used for compaction shall be the rolling type, vibratory type, or combination of both types, and shall be of sufficient capacity to meet the compaction requirements herein.

6.51.03 Layout of Work

(A) The CONTRACTOR shall stake or otherwise delineate the proposed alignment of the path according to the drawings. Obtain approval of the CITY INSPECTOR prior to proceeding with excavation and subgrade preparation.

(B) Cut/fill bench for the crusher fines as shown on the drawings.

(C) Cut existing grade to a minimum of seven inches (7") deep or as shown on the drawings within limits of paving. Wet and roll subgrade to obtain a firm, uniform, compacted subgrade. Keep cut sides vertical and true to line horizontally with a uniform width.

(D) Make sure proper drainage is available to ensure no standing water on the surface or adjacent to crusher fines.

6.51.04 Weed Control

(A) Apply Casoron 4G granular weed and grass killer or approved equal to prepared subgrade per manufacturer's recommendations.

(B) Apply Casoron 4G granular weed and grass killer at a rate of two hundred fifty to three hundred (250 – 300) pounds per acre. Apply approved equal at manufacturers recommended rate.

(C) Herbicides or other chemicals shall be applied using well-maintained equipment by individuals working for the CONTRACTOR who are properly licensed by any State and/or Federal Agency having jurisdiction over such applications. It shall be the responsibility of the CONTRACTOR to be knowledgeable of any and all current laws and regulations pertaining to herbicide and other chemical applications, and to notify the CITY ENGINEER immediately if any request for herbicide or chemical applications by the CITY ENGINEER is inappropriate as they pertain to these laws and regulations.

(D) Herbicides or other chemicals shall not be applied during periods when wind or other physical conditions cause the herbicides or chemicals to be transported a distance of more than five feet (5') from the immediate area where they are being placed. It shall be the responsibility of the CONTRACTOR to stop the work immediately and notify the CITY ENGINEER if any weather or other physical condition exists, which would make the application of herbicides or other chemicals inappropriate.

(E) All herbicides or other chemicals used shall be applied at a rate and strength, and by the method recommended by the manufacturer of the product being used.

6.51.05 <u>Placement and Compaction</u>

(A) The CONTRACTOR is responsible for controlling placement of the material; no additional compensation will be made for material placement in excess of the specified thickness or width.

(B) Do not install crusher fines material during rain or snow. Do not install crusher fines on sub-grade that has standing water.

(C) If the required compacted depth of the crusher fines exceeds six inches (6"), place course in two or more layers of approximately equal thickness. The minimum thickness of any one layer shall be four inches (4").

(D) Add water to plus-minus two percent (±2%) wet of optimum moisture content. Use roller or mechanical hand tamper for compaction. Compact to ninety-five percent (95%) Standard Proctor Density (ASTM D698) to a uniform thickness.

(E) Use plate compactor on edges and hard to get areas.

(F) Loose material shall not be present on final surface.

(G) Top of path shall be flush with adjacent grade. Remove any excess gravel on edges. Ensure that there are no low spots, high spots, or standing water on or adjacent to path.

6.51.06 Surface Finishing

(A) Use a smooth steel wheel roller for the final rolling of top surface of Crusher Fines. Water surface and evenly spread loose stones before final rolling. Make minimum of two complete passes over area to embed stones. Correct soft spots developed during rolling.

(B) Compacted surface shall be smooth and free from waves and other irregularities. Unsatisfactory portions of surfacing shall be torn up, reworked, re-laid, and rerolled at no additional expense to the project.

6.51.07 Inspection

(A) Finished surface shall be uniform and solid, with no evidence of chipping or cracking.

(B) Compacted paving material shall be firm to the full depth of pavement with no soft areas.

(C) Loose material shall not be present on the surface.

(D) No ruts shall be visible on the surface of the pavement.

(E) Pavement sections that do not meet this specification, shall be repaired or replaced at the CONTRACTOR's expense.

6.51.08 Repairs

(A) Excavate damaged area to depth of crusher fines paving material and square off sidewalls.

(B) If area is dry, moisten damaged portion lightly and scarify.

(C) Apply crusher fines to excavated area to finished grade.

(D) Compact with an eight-inch to ten-inch (8" to 10") hand tamp or one thousand pound (1000 lb.) roller.

(E) Repaired surface shall be smooth and free from waves and other irregularities. Unsatisfactory portions of surfacing shall be torn up, reworked, re-laid, and rerolled at no additional expense to the project.

6.52.00 MICRO-TRENCHING

6.52.01 General

This work consists of open trench cuts in the asphalt or concrete that are no less than eight inches (8") deep and no greater than twenty-four inches (24") deep, and no greater than two inches (2") wide to install conduit. Only one (1) DEVELOPER is allowed per Micro-trench.

The Micro-trenching installation methods allowed will be along a concrete gutter lip or a two foot (2') offset from the concrete gutter lip, and where a transverse street crossing is necessary. The CITY ENGINEER shall have sole discretion on which installation method will be used. All street crossings shall be approved by the CITY INSPECTOR. Restoration shall be approved by the CITY INSPECTOR. Micro-trenching shall only be allowed after written by the CITY ENGINEER.

All materials used in this operation shall be according to the requirements contained in these STANDARDS AND SPECIFICATIONS.

6.60.00 CONSTRUCTION TRAFFIC CONTROL

6.60.01 General

Traffic control devices shall be maintained in a safe operating condition and in compliance with current MUTCD standards at all times. The CONTRACTOR shall provide for approval by the Traffic Engineer, a traffic control plan, and shall comply with Chapter 8 of these STANDARDS AND SPECIFICATIONS. If the CITY ENGINEER finds the construction area to be inadequately barricaded, he has the authority to stop work and direct that corrective measures be taken prior to proceeding with work.

6.60.02 Pedestrian Traffic

Every precaution shall be taken to ensure that construction work does not interfere with the movement of pedestrian traffic, which shall be maintained on the sidewalk at all times. Flagmen shall be provided for guidance as necessary.

(A) Where an excavation interrupts the continuity of the sidewalk, the CONTRACTOR shall provide suitable bridge or deck facilities to be supplemented by the use of such proper devices and measures as prescribed in the MUTCD, most recent edition, for the safe and uninterrupted movement of pedestrian traffic. The edges or ends of the pedestrian bridge or decking shall be beveled or chamfered to a thin edge to prevent tripping.

(B) Temporary diversion walkways shall be hard surfaced and electric lighting shall be provided and kept continuously burning during hours of darkness, when required by the CITY ENGINEER.

(C) Unless otherwise authorized by the CITY ENGINEER, pedestrians shall not be channeled to walk on the traveled portion of the roadway.

(D) Under certain conditions, it may be necessary to divert pedestrians to the sidewalk on the opposite side of the street. Such crossings shall only be made at intersections or marked pedestrian crossovers. Detectable barricades meeting accessibility requirements shall be provided.

(E) Facilities satisfactory to the CITY ENGINEER shall be provided for pedestrian crossing at corners, pedestrian crossovers, and public transportation stops. Closures which affect transit stops or transit routes must be coordinated with the City Engineer and RTD prior to closures.

(F) Pedestrian detour routes during construction shall be ADA accessible.

6.60.03 <u>Vehicular Traffic</u>

(A) Construction work zone traffic shall be controlled by signs, barricades, detours, etc., which are designed and installed in accordance with the MUTCD, most recent edition, and applicable STANDARDS AND SPECIFICATIONS. Traffic control plan shall be submitted and approved by the CITY ENGINEER prior to start of any construction.

(B) During construction of new facilities, traffic control should strive to keep the motorist from entering the facility. The primary means to accomplish this is by use of temporary barricades, located in advance of the point where new construction joins existing, and by appropriate signing. New construction shall not be opened to traffic and, thus, the construction traffic control removed without the approval of the CITY INSPECTOR and the TRAFFIC ENGINEER.

(C) In general terms, a construction traffic control plan must be drawn on a map. For minor projects or local roadways, a neat sketch of the roadways and the proposed control devices will suffice. For major projects or major roadways, the traffic control plan should be superimposed on as-builts, construction plan drawings, or other detailed map.

(D) The MUTCD shall be the basis upon which the TRAFFIC CONTROL PLAN is designed in concern with proper, prudent, and safe engineering practice. All necessary signing, striping, coning, barricading, flagging, etc. shall be shown on the plan.

(E) Minimum travel lane width in construction areas shall be ten feet (10'). Turning movements on roadways may be restricted, but proper controls

including flagging must be indicated. Removal of on-street parking should be considered and noted where applicable.

(F) The approved PERMIT lane closure restriction times will govern when lane closures are allowed.

(G) Full road closures are not permitted. A variance from this requires approval from the CITY ENGINEER.

6.60.04 Bicycle Traffic

(A) Bicycles shall be considered in the development of a TRAFFIC CONTROL PLAN. If work causes the closure of a bicycle lane, the MHT shall include bicycle lane closure signage.

(B) If a bicycle path or multi-use path is closed, appropriate bicycle detour signage shall be provided. Detours shall be along facilities appropriate for bicycle traffic.

6.70.00 MATERIAL SPECIFICATIONS

6.71.00 BASE

The use of base is allowed in private streets and private parking lots only. Base shall consist of a foundation course composed of crushed gravel or crushed stone and filler constructed on the prepared subgrade or subbase course. Materials and construction shall be in accordance with the requirements of the CDOT's "Standard Specifications for Road and Bridge Construction." Gradation shall be Class 6 (3/4-inch maximum) in accordance with the following gradation:

TABLE 6.71.00
CLASSIFICATION TABLE FOR AGGREGATE BASE COURSE

Sieve Designation	Percent by Weight Passing Square Mesh Sieve Class 6
¾ inch	100
#4	30 – 65
#8	25 – 55
#200	3 – 12

Liquid Limit -- 30 Maximum
Plasticity Index -- 6 Maximum
R-Value Minimum -- 78

6.72.00 HOT MIX ASPHALT PAVEMENT

6.72.01 Description

(A) General

This work shall consist of providing an Asphalt Paving Mixture (APM) to be placed as shown on the plans, or as directed by the CITY ENGINEER. The CONTRACTOR shall be responsible for Process Control (PC) of the APM; including the design, and control of the quality of the material incorporated into the project. The CITY ENGINEER will be responsible for Owners Acceptance (OA); including testing, to assure the quality of the material incorporated into the project meet design parameters. The following specifications include general requirements applicable to all types of plant mixed asphalt pavements. The work shall meet the requirements within the contract documents and in conformity with the lines, grades, thickness, and design cross sections as shown on the plans or established by the CITY ENGINEER.

This specification is to maximize the service life of APM. It is also the intent of this document to provide construction requirements in accordance with these specifications to the standard of practice. This item shall include all labor, equipment, and materials to produce, place, and compact asphalt pavement.

(B) Definition of Terms

Wherever the following abbreviations are used in the specifications or other contract documents, the intent and meaning will be interpreted as shown below:

AASHTO: American Association of State Highway & Transportation Officials

ASTM: American Society for Testing & Materials

APM: Asphalt Paving Mixture

RAP: Reclaimed Asphalt Pavement

SMA: Stone Matrix Asphalt (at locations required by the CITY ENGINEER)

(C) Process Control

At least 10 business days prior to placing any mixture on the project, the CONTRACTOR shall submit a mix design for acceptance.

The CONTRACTOR shall assume full responsibility for controlling all operations and processes to meet the Specifications. The CONTRACTOR shall perform all tests necessary for process control purposes and maintain a log of all process control testing. Owners Acceptance (OA)

and/or Process Control (PC) test results will be evaluated to determine acceptability.

6.72.02 Materials

(A) General

Asphalt mixtures may consist of aggregate, filler, anti-strip agent, Recycled Asphalt Pavement (RAP) and asphalt binder.

The top layer of asphalt shall be stone matrix asphalt (SMA) or hot mix asphalt pavement (HMA) Grading SX. The lower layers may consist of HMA Grading SG or HMA Grading S. SMA mixes will only be required as determined by the CITY ENGINEER. The minimum layer thickness shall be 2 inches and each layer should be a minimum of 2 times the aggregate size.

(B) Aggregate

The Aggregate shall be of uniform quality, composed of clean, hard, durable particles of crushed stone, crushed gravel. The material shall not contain clay balls, vegetable matter, rounded aggregate, or other deleterious substances, and shall meet the following requirements:

TABLE 6.72.01
Aggregate Properties

Aggregate Test Property	Coarse: Retained on #4	Fine: Passing the #4
Fine Aggregate Angularity, CP-L 5113 Method A or AASHTO T 304 (Does not apply to RAP aggregate)		45% min.
Two Fractured Faces, ASTM D 5821 SG Mixtures Top and Middle Lifts Bottom Lifts SMA Mixtures	 90% min. 80% min. 70% min. 100% required	
Flat and Elongated (Ratio 5:1) % AASHTO M 283	10% max.	
Sand Equivalent. AASHTO T 176		45% min.
Micro Deval (for combined samples) AASHTO T 327	18% max. for design 20% max. for production	
LA Abrasion, AASHTO T 96 SMA Mixtures	 30% max.	

TABLE 6.72.02
Dense Graded Mixture Gradation
(AASHTO T 11 & T 27)

	SX (1/2" nominal) Top and Bottom Lifts, Patching	S (3/4" nominal) Lower Lifts	SG (1" nominal) Lower Lifts
Sieve Size	Percent Passing		
1.5"			100
1"		100	90-100
3/4"	100	90-100	
1/2"	90-100		
#8	28-58	23-49	19-45
#200*	2-8	2-7	1-7

* Shall include 1% by total weight if lime is used as the anti-strip agent.

TABLE 6.72.03
SMA Mixture Gradation
(AASHTO T 11 & T 27)

	1/2"	3/4"
Sieve Size	Percent Passing	
1"		100
3/4"	100	90-100
1/2"	90-100	50-88
3/8"	50-80	25-60
#4	20-35	20-28
#8	16-24	16-24
#30	12-18	12-18
#200	8-11	8-11

(C) Reclaimed Asphalt Pavement (RAP)

Allowable percentages of RAP in APM are shown in Table 6.72.04.

TABLE 6.72.04
RAP Allowed in APM Mixtures

Mix Grading	Max. % RAP allowed
SX (1/2")	25%
S (3/4")	25%
SG (1")	35%
SMA (1/2" & 3/4")	Not Allowed

(i) Quality of RAP

RAP may be used where allowed and shall be of uniform quality and gradation with a maximum size no greater than the nominal aggregate size of the mix. RAP shall not contain clay balls, vegetable matter, or other deleterious substances.

Asphalt mixtures containing RAP shall meet the same gradation and physical requirements as in Table 6.72.01.

Verification testing on RAP for asphalt content and gradation will be performed at the frequencies listed on Table 6.72.06, below. The CONTRACTOR shall provide testing results on RAP mixtures daily for properties listed in this specification.

The aggregate obtained from the processed RAP shall be based on the required gradation limits for the mixture being used. The aggregate and binder obtained from the processed RAP shall meet the tolerances provided in Table 6.72.05.

TABLE 6.72.05
RAP Binder & Aggregate Uniformity Tolerances

Element	Standard Deviation
Binder Content	0.5
% Passing 3/4"	4.0
% Passing 1/2"	4.0
% Passing 3/8"	4.0
% Passing #4	4.0
% Passing #8	4.0
% Passing #30	3.0
% Passing #200	1.5

(ii) Process Control (PC) Plan for RAP

A PC plan detailing how the RAP will be processed and controlled shall be developed and followed by the asphalt producer/CONTRACTOR and shall address the following:

A plan that explains the contractor's processing techniques for crushing, screening, rejecting, and stockpile operation.

RAP shall be tested as shown in Table 6.72.06.

TABLE 6.72.06
Test Frequency of Processed RAP

Test	Minimum testing frequency (minimum 3 tests)
Asphalt Binder Content (AASHTO T 164)	1/1,000 tons
Gradation (AASHTO T 30)	1/1,000 tons

Process control charts shall be maintained for binder content and each screen when RAP material is added to the stockpile. Separate control charts for each RAP stockpile shall be maintained. These charts shall be displayed and shall be provided upon request.

(D) Mineral Filler

Mineral filler for use with Stone Matrix Asphalt (SMA) pavement may consist of limestone dust or any other material filler that will meet the requirements of this subsection and have a maximum Plasticity Index (AASHTO T 90) of less than or equal to 4.0%.

The CONTRACTOR shall submit hydrometer analysis (AASHTO T 88) for the gradation of mineral filler used in the SMA mixture.

(E) Performance Graded Asphalt Binders

The CONTRACTOR shall provide to the CITY INSPECTOR an acceptable submittal of each applicable asphalt binder grade from the supplier. Should testing or certificate show nonconformance with the specifications, the asphalt binder may be rejected. When production begins, the CONTRACTOR shall, upon request, provide to the CITY ENGINEER a one quart can of each specified asphalt binder for analysis. Additionally, the CONTRACTOR shall provide the refinery test results that pertain to the asphalt binders used during production.

(F) Asphalt Binder

Asphalt binder shall meet the requirements of the Performance-Graded Binders (PG) as presented in Table 6.72.07 and consult www.LTTPbind.com when special circumstances arise.

On arterial streets the grade of asphalt cement for the top layer shall be PG 76-28 (Polymer Modified). The bottom layers may be PG 64-22. On all other street classifications, the grade of asphalt cement for the top layer shall be PG 64-28 (Polymer Modified). The bottom layers may be PG 64-22.

TABLE 6.72.07
Properties of Performance Graded Binders

Property of Binder Grade	PG 58-28	PG 64-22	PG 76-28
Flash Point Temperature, ˚C, AASHTO T 48	230 min.	230 min.	230 min.
Viscosity at 135 ˚C, Pas, ASTM D 4402	3 max.	3 max.	3 max.
Dynamic Shear, Temperature ˚C, where C/Sin ō @ 10 rad/sec. ≥ 1.00 Kpa, AASHTO TP 5	58 ˚C	64 ˚C	76 ˚C
Rolling Thin Film Oven Residue Properties, AASHTO T 240			
Mass Loss, %, AASHTO T 240	1.00 max.	1.00 max.	1.00 max.
Dynamic Shear, Temperature ˚C, where G/Sin ō @ 10 rad/sec. ≥ 2.20 Kpa, AASHTO TP 5	58 ˚C	64 ˚C	76 ˚C
Elastic Recovery1, 25 ˚C, % Min.	N/A	N/A	50 min.
Pressure Aging Vessel Residue Properties, Aging Temperature 100 ˚C, AASHTO R 28			
Dynamic Shear, Temperature ˚C, where G/Sin ō @ 10 rad/sec. ≤ 5,000 Kpa, AASHTO TP 5	19 ˚C	25 ˚C	28 ˚C
Creep Stiffness, @ 60 sec. Test Temperature in ˚C, AASHTO TP 1	-18 ˚C	-12 ˚C	-18 ˚C
S, Mpa, AASHTO TP 1	300 max.	300 max.	300 max.
m-value, AASHTO TP 1	0.300 min.	0.300 min.	0.300 min.

(G) Anti-Strip Additives

Anti-Strip shall be added into the APM. Anti-Strip agents shall be lime (added to the aggregates), and shall be submitted for approval by the CITY ENGINEER.

The minimum value for Tensile Strength Ratio (TSR) shall be 80% for the mix design and 70% during production.

(H) Hydrated Lime

The hydrated lime for APM shall conform to the requirements of AASHTO M 303, Type I. In addition, the particle size requirements shall conform to AASHTO M 303 when tested in accordance with CP-L 4209 Physical Testing of Quicklime, Hydrated Lime, and Limestone. Hydrated Lime shall be added at the rate of 1% by dry weight of the aggregate and shall be included in the amount of material passing the No. 200 sieve.

6.72.03 Mix Design and Production Requirements

(A) General

There shall be no substitutions of materials allowed during production. All substitutions will require checkpoint verification. If the checkpoint differs from the Job Mix Formula (JMF), a new mix design will be required. Upon request of the CITY ENGINEER, the binder grade may be changed by one available binder grade level without requiring a new mix design.

The mix design shall include the criteria concerning mix design method, traffic level, binder type, mixture grading, and percent of RAP allowed.

Grading SG (1-inch nominal aggregate) shall only be designed using the 150mm molds. Hveem Stability is not required for Grading SG mixtures. Grading ST, SX, and S shall be designed using 100mm molds.

(B) Mixture Design Submittals

The CONTRACTOR shall submit all mix designs and laboratory data to the CITY INSPECTOR for approval.

Designs shall be developed and performed in a materials laboratory that meets the requirements set forth by AASHTO Materials Reference Laboratory (AMRL) for all testing procedures. The design shall be stamped and signed by a Professional Engineer licensed in the State of Colorado. In addition, the CONTRACTOR shall submit, as part of the mixture design, laboratory data documents to verify the following:

- Gradation, specific gravity, source and description of individual aggregates and the final blend.
- Aggregate physical properties.

- Source and Grade of the Performance Graded Binder.
- Proposed Design Job Mix: aggregate and additive blending, final gradation, optimum binder content.
- Mixing and compaction temperatures used.
- Mixture properties shall be determined with a minimum of four binder contents.

The CITY ENGINEER reserves the right to verify the asphalt supplier's mix design for each APM design utilizing materials produced and stockpiled. The asphalt supplier shall provide, at no cost, a sufficient quantity of each aggregate, mineral filler, RAP, and additive for the required laboratory tests, as well as all Certificates of Conformance/ Compliance at any time on any material used. The Asphalt Supplier shall provide copies of quality control testing results during the production of APM used within three business day from the sampling date.

(C) Mixture Design Method

A Job Mix Formula (JMF) design shall be submitted for each mixture required for review by the CITY ENGINEER. The JMF design shall be determined using AASHTO T-312 for the Method of Mixture Design.

Mixture design and field control testing of dense graded asphalt mixes shall meet the requirements of Table 6.72.08.

Mixture design and field control testing of SMA shall meet the requirements of Table 6.72.09.

TABLE 6.72.08
Mixture Properties for Dense Graded Asphalt Mixtures

Property	Traffic Level (ESALs)	
	<100,000	≥100,000 to 3 million
Design Gyrations, N_{design}	50	75
Air Voids (V_a) % at N_{design} (AASHTO T 132)	3.0 – 4.0	3.0 – 4.0
Hveem Stability (AASHTO T 246) (Grading ST, SX & S only)	28 min.	28 min.
Voids Filled with Asphalt (V_a), MS-2	70-80	65-80
Dry Tensile Strength, psi (AASHTO T 283)	30 min.	30 min.
Voids in Mineral Aggregates (VMA) % (AASHTO PP-19)	Table 6.72.10	

TABLE 6.72.09
Mixture Properties for SMA

Property	Test Method	Value
Lab Compaction (Gyrations) N_{design}	AASHTO T 312	75
Air Voids (V_a) % at N_{design}	AASHTO T 312	3.0 – 4.0
Accelerated Moisture Susceptibility, Tensile Strength Ratio, (Lottman)	AASHTO T 283, Method B	80 min.
Dry Split Tensile Strength. psi	AASHTO T 283, Method B	30 min.
Grade of Asphalt Binder	N/A	PG 76-28
Voids in the Mineral Aggregate (VMA) %, minimum	AASHTO PP19	17
Drain Down at Production Temperature	AASHTO T 305	0.3 max.

TABLE 6.72.10
Minimum Voids in Mineral Aggregate (VMA)
Dense Graded & SMA Mixes

Nominal Maximum Particle Size	Minimum VMA (%)		
	3.0% V_a	3.5% V_a	4.0% V_a
1/2" (SX)	14.5	14.6	14.7
3/4" (S)	13.5	13.6	13.7
1" (SG)	12.5	12.6	12.7
SMA – 1/2"	17.0	17.0	17.0
SMA – 3/4"	17.0	17.0	17.0

(D) Change in Source or Grade

Should a change in the source of any material used in the production of APM (aggregate, mineral filler, lime, or performance graded asphalt binder) occur, a one-point verification test (at optimum binder content) of the mix must be performed to verify that the applicable criteria shown on Table 6.72.08 (dense graded APM), Table 6.72.09 (SMA), and Table 6.72.10 (VMA), is still met. If this testing shows noncompliance, the CONTRACTOR shall establish a new job mix design and obtain approval by the CITY ENGINEER before the new APM is used.

(E) Mix Production Verification

Production verification shall occur prior to the start of the project. Volumetric properties of the mix shall be verified by LabCAT Level C certified Technicians. If the mix was produced for another project within the last 90 days, data from that project can be submitted for verification. Volumetric properties for mix verification testing shall be within the tolerances in Table 6.72.14. The mix verification test reports shall be submitted to the CITY ENGINEER prior to mix placement.

Verification testing for binder content, gradation and physical properties shall be performed at the frequencies listed in Table 6.72.15.

(F) Pre-Paving Meeting

The CITY ENGINEER may require a pre-paving meeting of all parties that are directly involved in the project. Traffic control, transport, sequence of paving and construction plans may be reviewed and discussed.

6.72.04 Production

(A) Preparation of Aggregates

Heating and drying of the aggregates shall be accomplished without damaging the aggregate. An Anti-Strip additive shall be added to achieve uniform coating of the aggregate, in accordance with Section 6.72.02(G) Anti-Strip Additives.

(B) Mixing

The dried aggregates and asphalt binder shall be combined in the mixer in the quantities required to meet the design job mix formula. The materials shall be mixed until the aggregate is uniformly coated, and the asphalt binder is uniformly distributed throughout the aggregate. Baghouse fines may be fed back to the mixing plant in a continuous manner to maintain uniformity in the mixture at the discretion of the producer.

Discharge temperatures are shown in Table 6.72.11.

TABLE 6.72.11
Mixture Discharge Temperatures

Binder Grade	Minimum Discharge Temperature	Maximum Discharge Temperature
PG 58-28	275 ˚F	305 ˚F
PG 64-22	290 ˚F	320 ˚F
PG 76-28	320 ˚F	330 ˚F

To protect the properties of the binder, APM shall be produced at the lowest temperature within the specified range that produces a workable mix and provides for uniform coating of aggregates, and that allows the CONTRACTOR to achieve the required compaction.

(C) Transportation

Colorado Statutes require that each truck shall be covered. This will also help protect the mix during transport from contamination and weathering. The CITY ENGINEER may reject any uncovered APM which demonstrates it has been impacted by contamination and/or weather.

6.72.05 Prime and Tack Coat

(A) Prime Coat

Materials shall be in accordance with the requirements of the CDOT's "Standard Specifications for Road and Bridge Construction."

(B) Tack Coat

Prior to placement of APM, a tack coat shall be applied to all existing concrete and asphalt surfaces.

The tack coat shall meet the CDOT "Standard Specifications for Road and Bridge Construction" for emulsified asphalt, consisting of CSS-1h or SS-1h and conform to AASHTO M208 or M140.

The tack coat shall be applied at a rate of 0.1 to 0.3 gallons per square yard. The surface receiving the tack coat shall be dry and clean, and dust, debris, and foreign matter shall be removed. Tack coat shall be applied uniformly. The CONTRACTOR shall allow the tack coat to cure (dehydrate) prior to the placement of APM. If the tack becomes contaminated during construction, it shall be cleaned, and if necessary, additional tack coat shall be reapplied and allowed to cure before paving resumes.

TABLE 6.72.12
Tack Coat Application Rates

Pavement Condition	Application Rate (gal/yd^2)		
	Residual	Undiluted	Diluted (1:1)
New Asphalt	0.03 – 0.04	0.05 – 0.07	0.10 – 0.13
Oxidized Asphalt	0.04 – 0.06	0.07 – 0.10	0.13 – 0.20
Milled Surface (Asphalt)	0.06 – 0.08	0.10 – 0.13	0.20 – 0.30
Milled Surface (PCC)	0.06 – 0.08	0.10 – 0.13	0.20 – 0.30
Portland Cement Concrete	0.04 – 0.06	0.07- 0.10	0.13 – 0.20

6.72.06 Equipment

(A) Transport Equipment

Trucks used for transporting APM shall be free of debris, and should be treated with approved release agents. Petroleum distillates such as kerosene or fuel oil will not be permitted as a release agent. The CITY ENGINEER may reject any APM which demonstrates it has been contaminated from a petroleum distillate release agent.

(B) Material Transfer

Placement of SMA shall require the use of a Material Transfer Vehicle (MTV) or Material Transfer Device (MTD). The MTV shall be a self-propelled unit with on board storage of material. An MTD is a non-self-propelled unit. Both MTV and MTD are capable of receiving material from trucks or from the ground, transferring the material from the unit to a paver hopper insert via a conveyor system.

(C) APM Pavers

Self-propelled pavers shall be capable of placing the APM to the desired width, thickness and a satisfactory mat texture.

Pavers shall be equipped with automatic screed controls, the sensors may be contact or non-contact type devices. The controls shall be capable of maintaining the screed at the specified transverse slope within ±0.1%.

6.72.07 Placement

(A) General

APM shall be placed on properly constructed surfaces that are free from debris, frost, snow, or ice. APM shall be placed in accordance with the temperature limitations of Table 6.72.13. In-place density for APM shall be 94% of maximum theoretical specific gravity (Rice - AASHTO T 209). The allowable variance shall be ± 2%. Test results shall be reported to the nearest whole number.

(B) Temperature

Surface temperatures shall be used to determine placement of APM. Ambient temperatures and other weather conditions shall be considered prior to placement.

TABLE 6.72.13
Minimum Surface Temperatures for Placement of APM

Compacted Layer Thickness (in.)	Minimum Surface Temperature (˚F)	
	Top Layer	Layers Below the Top Layer
<1-1/2	60	50
1-1/2 - <3	50	40
3 or more	45	35

If the CONTRACTOR modifies the placement and compaction processes when ambient temperatures are below minimum surface temperatures in Table 6.72.13, they shall demonstrate to the CITY ENGINEER the required in-place density has been achieved. APM cooling software such as PaveCool or MultiCool can be used to determine placement and compaction times available.

(C) SMA Placement

The CONTRACTOR shall establish and document a roller pattern for the SMA being placed. The roller pattern shall include, but is not limited to the following:

- Number, size, and type of rollers
- Amplitude, frequency, and speed of rollers
- Temperature of mixture being compacted during each process (break down, intermediate and finish)
- Number of roller passes for each phase

The in-place density shall be determined during placement of the first 1,000 feet with a minimum of 95% of Theoretical Maximum Density (Rice). The allowable variance shall be ± 2%. Test results shall be reported to the nearest whole number.

SMA mixture shall be placed with the assistance of a MTV or MTD. The CONTRACTOR should minimize flushing and drain down during the transport and placement of SMA. If more than 50 square feet of flushed area is observed, the CONTRACTOR shall provide a remedy to address the flushing and/or drain down.

In place density may be determined by nuclear gauge measurements in accordance with ASTM D 2950 and AASHTO T 230, or based on cores in accordance with AASHTO T 166, Method B. When cores are used, the CONTRACTOR shall provide all labor and equipment for the coring and repair of the holes.

When the material being placed is on a structure (bridge deck), nuclear gauge measurements shall be used.

6.72.08 Longitudinal Joints

The CONTRACTOR shall submit a joint plan and pavement marking plan showing the location of and the methods to establish the paving control lines. The plan shall be approved by the CITY ENGINEER. The CONTRACTOR shall use a method to delineate longitudinal joints during paving.

Longitudinal joints in all pavement layers shall offset the joint in the layer immediately below by a minimum of six inches. The joint in any pavement layer shall not fall in wheel paths. Joints in the top layer of new pavement shall be located on lane lines unless otherwise shown on the plans. Longitudinal joints shall be minimized with wide paving pulls. Joints shall be parallel to the flow of traffic and shall not cross any centerline, lane line, or edge line.

All paving shall be placed parallel to the roadway centerline and as straight as possible. All joints shall receive a coat of tack prior to placement of adjacent paving.

6.72.09 Transverse Joints

The CONTRACTOR shall submit a joint plan. The plan shall be approved by the CITY ENGINEER. The CONTRACTOR shall use an approved plan to delineate transverse joints during paving. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Tack coat material shall be applied to contact surfaces of all joints before additional mixture is placed against the previously compacted material.

The surface tolerance at the transverse joint shall be verified by the CONTRACTOR with a 10 foot straight edge. If the surface tolerance exceeds 3/16" across the joint, measured in at least three locations, the CONTRACTOR shall make corrections to the joint before proceeding.

6.72.10 Segregation

Visually segregated areas shall be corrected before the initial compaction process is applied. Segregated areas may be determined visually or by other acceptable means. The CONTRACTOR shall correct segregated areas to the satisfaction of the CITY ENGINEER.

6.72.11 Compaction

Equipment used for compaction of the APM will be at the discretion of the CONTRACTOR. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density and surface texture.

When the mixture contains unmodified asphalt binder (PG 58-28 or PG 64-22), and the surface temperature falls below 180˚F, further compactive effort shall

not be applied unless the CONTRACTOR can demonstrate that there is no damage to the finished mat.

If the mixture contains modified asphalt binder (PG 76-28) and the surface temperature falls below 230˚F, further compactive effort shall not be applied unless the CONTRACTOR can demonstrate that there is no damage to the finished mat.

Use of rollers with the vibrator on will not be permitted on bridge decks.

In-place density for APM shall be 94% of maximum theoretical specific gravity (Rice - AASHTO T 209). The allowable variance shall be ± 2%. Test results shall be reported to the nearest whole number. Rice values will be based on a three production day's average. The CONTRACTOR shall provide the producer's Rice value, which shall be used for production until the actual day's Rice value is determined by the testing firm of record for the project.

In place density for SMA shall be determined during placement of the first 1,000 feet with a minimum of 95% of theoretical maximum specific gravity Rice - AASHTO T 209). The allowable variance shall be ± 2%. Test results shall be reported to the nearest whole number.

All joints shall be compacted to 92% of Rice, taken six inches offset from the joint, at a minimum of one every 1000 linear feet or fraction thereof. The allowable variance shall be ±2%. Test results shall be reported to the nearest whole number.

The CONTRACTOR shall core the pavement, as required by the CITY ENGINEER; in accordance with AASHTO T 230, Method B, or for field calibration of nuclear density equipment in accordance with the ASTM D 2950. At a minimum, cores for nuclear density equipment correlation shall be taken at the beginning of placement of each pavement layer or change of mixture materials or gradation. Cores may be used to verify compaction results.

Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall meet all project compaction specifications. Any mixture that is defective, shall be corrected to meet the project specifications at the expense of the CONTRACTOR.

6.72.12 Utility Adjustments

The CONTRACTOR shall adjust all manholes to 1/8" maximum below final grade and adjust to match the slope of the roadway in accordance with the detail drawings. Valve boxes and survey range boxes shall be adjusted to be flush to 1/8" below final grade and adjusted to match the slope of the roadway. Valve boxes shall be adjusted with each layer of paving.

Valve boxes and manholes are to be maintained fully accessible at all times for emergency and maintenance operations. The cost of adjusting valve boxes, manholes, and survey range boxes shall be included in the work, unless

otherwise specified. The CONTRACTOR shall be responsible for any cost to provide access to the covered manholes or valve boxes at the discretion of the CITY ENGINEER.

Final adjustment of all utility access points shall be completed within seven days from the time the APM was placed.

6.72.13 Production Tolerances

(A) Wearing Course

Surface variation shall not exceed 3/16 inch in 10 feet for full lane width paving. For patching, the variation shall not exceed 3/8 inch in 10 feet. The final pavement surface shall not vary from the specified cross section by more than one inch at any point. Transverse measurements for variations shall exclude breaks in the crown sections. Corrections shall be made at the CONTRACTOR's expense.

The final surface pavement adjacent to curb and gutter shall be finished from 1/8-inch to 1/4-inches above the lip for catch curb and shall not extend above the lip for spill curb.

(B) Job Mix Formula

Tolerances for gradation are presented in Table 6.72.02 and Table 6.72.03. APM volumetric tolerances are presented in Table 6.72.14.

TABLE 6.72.14
Production Mix Tolerances

Property	Tolerance
Air Voids	± 1.2%
VMA	± 1.2%
Asphalt Binder Content	± 0.3%

6.72.14 Conformity with Plans and Specifications

(A) Materials

Materials shall be sampled by and tested by a LabCAT certified technician(s) in an AMRL accredited testing laboratory in accordance with Section 6.72.15.

Test results that have sampling or testing errors shall not be used.

(B) Pavement Thickness

A minimum of 90% of all the pavement thickness cores must equal or exceed the required thickness shown on plans or pavement design report.

If the pavement thickness deficiency is greater than 0.25 inches for individual cores, two additional cores will be taken by the CONTRACTOR 50 feet before and after each deficient core. The three core results will be averaged to determine if the results meet the required thickness.

When individual core thickness deviates from the target thickness by more than 0.25 inch but not more than 0.50 inch, remedial action will be required. The CONTRACTOR shall present proposed remedial measures for consideration by the CITY ENGINEER. The CITY ENGINEER will review the proposal within 10 working days to accept or modify the remedial measures. The remedial measures will be performed by the CONTRACTOR at no additional cost to the CITY.

When individual core thickness deviates from the target thickness by more than 0.50 inch, corrective action shall be required. The deficient area will overlaid with no less than one inch thick lift to meet the design thickness. The CONTRACTOR will mill to match existing facilities prior to corrective overlay. The mixture proposed shall be approved by the CITY ENGINEER. Corrective action will be performed by the CONTRACTOR within 15 working days.

If the CITY ENGINEER does not want the top lift cored, they may require the CONTRACTOR to use non-destructive survey techniques to determine APM thickness.

6.72.15 Testing and Inspection

If any materials furnished or work performed fails to meet the specification requirements, such deficiencies shall be documented and reported to the CITY ENGINEER. Field reports shall be delivered to the CITY ENGINEER within three business days. Test results that cannot be completed within three days shall be provided to the CITY ENGINEER no later than one week after the sample was obtained.

Testing of APM shall be performed in accordance with Table 6.72.15. Laboratories shall be accredited by AASHTO Materials Reference Laboratory (AMRL) for the tests being performed. Technicians obtaining samples and conducting compaction tests must have a LabCAT Level A certification. Technicians conducting tests of asphalt content and gradation must have a LabCAT Level B certification. Technicians performing volumetric testing must have a LabCAT Level C certification. Inspectors on APM projects shall be LabCAT Inspector Certified (Level I).

TABLE 6.72.15
Minimum Materials Sampling and Testing
for Process Control and Owners Acceptance

Test	Standard	Minimum Frequency
Sampling	AASHTO T 168, ASTM D 979 & ASTM D 3665	1/1000 tons or fraction thereof (not less than one test per day)
Density	AASHTO T 166, T 238 & T 230	One test for each 250 linear feet per lane
Thickness (Core)	ASTM D3549	As required
Air Voids & VMA	AASHTO T 166 & PP19	1/1000 tons or fraction thereof (not less than one test per day)
Gradation	AASHTO T 27 & T 11	1/1000 tons or fraction thereof (not less than one test per day)
Hveem/Marshall Stability As Applicable	AASHTO T 245 & T 246	1/1000 tons or fraction thereof (not less than one test per day)
Binder Content	AASHTO T 164 or other methods agreed upon between the CITY and CONTRACTOR	1/1000 tons or fraction thereof (not less than one test per day)
Maximum Theoretical Specific Gravity (Rice)	AASHTO T 209	1/1000 tons or fraction thereof (not less than one test per day)
Lottman Stripping, TSR & Dry Density	AASHTO T 283	One per project per mix used

6.72.16 Crack Seal Required

Following construction of new streets and/or alleys as part of a PUBLIC IMPROVEMENTS AGREEMENT, the OWNER/DEVELOPER shall conduct crack seal operations at the direction of the CITY ENGINEER on the asphalt surface one year after initial construction. Cracks with a width greater than one-eighth inch (1/8") shall be sealed with crack sealing compound conforming to Section 408 of the CDOT specifications.

6.73.00 APPURTENANT STRUCTURES CONCRETE

Concrete used in the construction of curb, gutter, sidewalk, drive cuts, and other appurtenant roadway concrete structures, including concrete pavement if allowed by the CITY ENGINEER, shall be in accordance with Chapter 7 of these STANDARDS AND SPECIFICATIONS.

6.74.00 STRUCTURE BACKFILL MATERIAL

Structure backfill shall comply with CDOT's specifications for Class 1 material and meet the following requirements from laboratory sieves:

TABLE 6.74.00

Sieve Designation	Percent by Weight Passing Lab Sieve
2 inch	100
#4	30 – 100
#50	10 – 60
#200	5 – 20

Flowable fill may be required or allowed in lieu of Class 1 backfill as determined by the CITY ENGINEER.

6.75.00 DETECTABLE WARNING TILES

6.75.01 General

(A) This section includes specifications for furnishing permanently embedded cast-in-place tactile / detectable warning surface tiles with an in-line truncated dome pattern embedded in all accessible curb ramps at the locations and to the dimensions shown on the detail and/or construction drawings, and as directed by the CITY ENGINEER.

(B) Provide cast-in-place tiles and accessories as produced by a single manufacturer with a minimum of five (5) years' experience in manufacturing Cast In Place Composite Shell Tactile Warning Surface Tiles.

6.75.02 Manufacturers

(A) Available manufacturers, subject to compliance with these STANDARDS AND SPECIFICATIONS include, but are not limited to, the following: ADA Solutions Inc. of Chelmsford, MA (Phone: 800-372-0519, Fax: 978-262-9125, Web Site: www.adatile.com , E: info@adatile.com), or approved equal.

(B) Requests for Approved Equal Status must be submitted and approved by the CITY ENGINEER.

6.75.03 Submittals

(A) Product Data: Submit manufacturer's literature describing products, installation procedures, and maintenance instructions.

(B) Samples for Verification Purposes: Submit two (2) Tactile Warning Surface samples minimum eight inches by eight inches (8" x 8") of the kind proposed for use. Samples shall be properly labeled and shall contain the following information: Name of Project, Submitted by, Date of Submittal, Manufacturer's Name, and Catalog Number.

(C) Shop Drawings: Submit Standard Manufacturer Shop Drawings showing all pertinent characteristics of the cast-in-place tile, including profile, sound on cane contact amplification feature, and installation methods.

(D) Material Test Reports: Submit current test reports from qualified, accredited independent testing laboratory in accordance with ASTM guidelines and indicating that materials proposed for use are in compliance with specification requirements and meet the properties indicated. All test reports submitted shall be representative of the cast-in-place tile delivered to the installation site.

(E) Maintenance Instructions: Submit copies of manufacturer's specified maintenance practices for each type of Tactile Warning Surface Tile and accessory.

6.75.04 <u>Tile Requirements</u>

(A) Cast-in-place tiles must be compliant with ADAAG and PROWAG requirements.

(B) Cast-in-place tiles shall meet or exceed the following test criteria using the most current test methods:

1. Compressive Strength: 28,900 psi minimum, when tested in accordance with ASTM D695.

2. Flexural Strength: 29,300 psi minimum, when tested in accordance with ASTM D790.

3. Water Absorption: Not to exceed 0.10%, when tested in accordance with ASTM-D570.

4. Slip Resistance: 1.05 minimum wet and 1.18 dry static coefficient of friction when tested in accordance with ASTM C1028.

5. Flame Spread: 25 maximum, when tested in accordance with ASTM E84.

6. Salt and Spray Performance of Tactile Warning Surface: No deterioration or other defects after 200 hours of exposure, when tested in accordance with ASTM-B117.

7. Chemical Stain Resistance: No reaction to 1% hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, and antifreeze, when tested in accordance with ASTM D543.

8. Abrasion Resistance: 500 minimum, when tested in accordance with ASTM C501.

9. Accelerated Weathering of Tactile Warning Surface when tested by ASTM-G155 or ASTM G151 shall exhibit the following result: $\Delta E<5.0$ at 2,000 hours minimum exposure.

10. Tensile Strength: 11,600 psi minimum, when tested in accordance with ASTM D638.

11. AASHTO-H20 Load Bearing Test: No Damage at 16,000# loading.

12. Freeze/Thaw/Heat: No deterioration when tested in accordance with ASTM C 1026.

6.75.05 <u>Delivery, Storage, and Handling</u>

Cast-in-place tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings.

Store cast-in-place tiles in an area that is within an acceptable temperature range (40-90 degrees). Maintain Storage Facility in a clean dry condition to prevent contamination or damage to cast-in-place tiles.

6.75.06 <u>Guarantee</u>

Cast-in-place tiles shall be guaranteed in writing for a period of five (5) years from date of Contract's final completion. The guarantee includes manufacturing defects, breakage, and deformation.

6.75.07 <u>Tile Materials</u>

(A) Composition: Cast-in-place tiles shall be manufactured using a matte finish exterior grade homogeneous (uniform color throughout thickness of product) glass and carbon reinforced polyester based Sheet Molding Compound (SMC) composite material. Truncated domes must contain fiberglass reinforcement within the truncated dome for superior structural integrity and impact resistance. A matte finish will be required

on the Tactile Warning Surface for superior slip resistance performance superior to that offered by a gloss finish. Use of Tactile Warning Surface Products employing coatings or featuring layers of material with differing composition, performance, or color properties is expressly prohibited under this Section.

(B) Color: Color shall be homogeneous throughout cast-in-place tile: Brick Red (R) per Federal Standard 595B Table IV, Color No. 20109.

(C) Domes: Square grid pattern of raised truncated domes of two-tenths inch (0.2") nominal height, base diameter of nine-tenths inch (0.9") and top diameter of forty-five hundredths inch (0.45"). The Federal Code of Regulations permits a truncated dome spacing range of one-point-six to two-point-four inches (1.6"-2.4"). For superior wheelchair, walker, and shopping cart mobility, the preferred truncated dome spacing shall have a center-to-center (horizontally and vertically) spacing of two-point-thirty-five inches (2.35"), measured between the most adjacent domes on square grid.

(D) Configuration: Cast-in-place tile sizes shall be as indicated on the detail and/or construction drawings. For superior load bearing capacity, cast-in-place tile shall feature internal embedment ribs at three inches (3") on center maximum. The field area shall consist of a non-slip textured surface with a minimum static coefficient of friction of eight-tenths (0.80), wet and dry. At a minimum, cast-in-place tile thickness shall measure two-tenths (0.20") (nominal).

(E) Truncated dome surface of cast-in-place tile shall be protected with factory installed plastic sheeting for cleanliness during the installation process. Basic installation guidelines shall be printed on the plastic sheeting in both English and Spanish for customer convenience.

(F) Dimensions: Cast-in-place tiles shall be held within the following length and width dimensions:

1. 1.67" Dome Spacing: 24"x36", 24"x48", or 24"x60"

2. 2.35" Dome Spacing: 24"x36", 24"x48", or 24"x60"

(G) Cleaning materials used on site shall have code acceptable low VOC solvent content and low flammability.

(H) The specifications of the concrete, sealants, and related materials shall be in accordance with these STANDARDS AND SPECIFICATIONS and the guidelines set by their respective manufacturers.

6.76.00 CRUSHER FINES AGGREGATE

6.76.01 Submittals

(A) The CONTRACTOR shall submit certification from the supplier certifying the crusher fines, or approved equal, meets the requirements of these STANDARDS AND SPECIFICATIONS.

(B) The CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

(C) The CONTRACTOR shall submit samples and or shop drawings for the following:

1. Aggregate strength.

2. Aggregate color.

(D) The CONTRACTOR shall submit the manufacturer, Material Safety Data Sheet (MSDS), Name, Trade Name, trademark, and conformance to state law of all herbicides or other chemicals.

6.76.02 Herbicide

Herbicide shall be Casoron 4G granular weed and grass killer or approved equal.

6.76.03 Crusher Fines

(A) Aggregates: Crushed stone shall consist of inert materials that are hard, durable, with stone free from surface coatings and deleterious materials.

(B) R-value minimum of seventy (70) determined by ASTM D 2488 Methodology (R-value is a measure of wear resistance).

(C) Sand equivalent: An engineering measurement of the proportion of sand to silt and clay will stay at a range of 30-55, as determined by ASTM D 2419 methodology.

(D) Gradations: Gradation shall meet the gradation below or approved equal as approved by the CITY ENGINEER.

TABLE 6.76.01
Crusher Fines Gradation

Standard US Sieve Size	Percentage Passing by Weight
1/2 Inch	100
3/8 Inch	100
No. 4	65-80
No. 8	48-63
No. 16	40-49
No. 30	30-40
No. 50	20-27
No. 100	10-18
No. 200	10-12

Note: Material shall consist of bank or pit run material.

TABLE OF CONTENTS

CHAPTER 7
CONCRETE

Page

7.00.00 INTRODUCTION 7-1

7.01.00 GENERAL 7-1
7.02.00 REMOVALS 7-1

7.10.00 DESIGN STANDARDS 7-1

7.20.00 CONSTRUCTION 7-1

7.20.01 Preparation 7-1
7.20.02 Timing 7-2
7.20.03 Concrete Temperature 7-2
7.20.04 Handling 7-2
7.20.05 Workability 7-3
7.20.06 Weather Restrictions 7-3
7.20.07 Jointing 7-4
7.20.08 Finishing and Curing 7-5
7.20.09 Testing of Concrete 7-7
7.20.10 Repairs 7-8

7.30.00 MATERIAL SPECIFICATIONS 7-9

7.31.00 CONCRETE MIX DESIGN 7-9
7.32.00 CONCRETE MATERIALS 7-9
7.32.01 Cement 7-10
7.32.02 Aggregate 7-10
7.32.03 Water 7-12
7.32.04 Admixtures 7-12
7.32.05 Fly Ash 7-13
7.33.00 REINFORCING STEEL 7-13
7.34.00 CURING MATERIALS 7-14
7.34.01 General 7-14
7.34.02 Liquid Curing Compound (Pigmented) 7-14
7.32.03 Liquid Curing Compound (Clear) 7-14
7.35.00 FORM WORK 7-14
7.35.01 Forms for Structures, Curbs and Sidewalks 7-14
7.35.02 Removal of Forms 7-15
7.35.03 Forms for Concrete Pavement 7-16
7.35.04 Slip-Formed Concrete Pavement 7-16
7.36.00 JOINTING MATERIAL 7-17
7.36.01 General Joint Materials 7-17
7.36.02 Concrete Pavement Joint Materials 7-17
7.37.00 BATCHING AND MIXING 7-18
7.37.01 General 7-18
7.37.02 Proportioning the Mix 7-18
7.37.03 Ready-Mixed Concrete 7-19

CHAPTER 7
CONCRETE

7.00.00 INTRODUCTION

7.01.00 GENERAL

This specification enumerates the requirements for the materials, storage, transportation, measuring, mixing, placing, and curing of Portland cement concrete. This specification applies to all Portland cement concrete used in but not limited to pavement, sidewalks, trails, shared pathways, driveways, approaches, alley ways, patches, manholes, inlets, and other structures constructed in the CITY. Engineering plans, licenses, permits, inspection, warranty, and acceptance shall be as detailed in these STANDARDS AND SPECIFICATIONS for the applicable type of construction involved. All applicable permits shall be obtained a minimum of 48 hours before work begins. The CONTRACTOR shall contact the CITY INSPECTOR a minimum of forty-eight (48) hours in advance of concrete placement when the form work is ready to receive the concrete. Where required, compaction test results and proof rolling shall verify the adequacy of all ground upon which concrete is to be placed. When proof rolling is required, a minimum five thousand (5,000) gallon loaded water truck or other loaded trucks approved by the CITY INSPECTOR shall be driven over the finished subgrade.

7.02.00 REMOVALS

All removals shall be to the limits shown on the approved drawings or as directed by the CITY INSPECTOR. Replacement or repair of damaged improvements outside of these limits shall be repaired at no expense to the CITY. Removals shall be to a clean vertical face or as shown in the approved plans.

7.10.00 DESIGN STANDARDS

Design specifications for sidewalks, curb and gutter, driveways, concrete pavement, inlets, and sidewalk are in this chapter. Design specifications for concrete pipe, manholes, inlets, and other drainage and wastewater concrete structures are in Chapter 3, Chapter 4 and Chapter 5 of these STANDARDS AND SPECIFICATIONS. Design specifications relative to traffic signals and traffic control items are in Chapter 8 of these STANDARDS AND SPECIFICATIONS.

7.20.00 CONSTRUCTION

7.20.01 Preparation

Before depositing concrete, debris shall be removed from the space to be occupied by the concrete and the forms. Concrete shall not be placed until all forms and reinforcing steel have been inspected and approved by the CITY INSPECTOR and all subgrade compaction test results or proof rolling have been verified. The soil receiving the concrete shall be moist, but not wet, and shall not contain frost or frozen material.

7.20.02 Timing

Concrete which has developed initial set or does not have workable consistency shall not be used. Concrete shall be continuously mixed or agitated from the time the water is added until the time of use, and shall be completely discharged from the truck mixer or truck agitator within one-and-one-half (1-1/2) hours after it comes in contact with the mixing water or with the aggregates. Retempered concrete will not be allowed.

7.20.03 Concrete Temperature

At the time of concrete placement, the mix temperature shall be between fifty degrees Fahrenheit (50°F) and ninety degrees Fahrenheit (90°F). In cold weather (see Section **7**.20.06), aggregates and water may be heated as part of the batching operation but they shall not be heated beyond a temperature of one-hundred-and-fifty degrees Fahrenheit (150°F). Aggregates shall not be heated directly by gas or oil flame or on sheet metal over direct flame. Materials containing frost or lumps of frozen material shall not be used in the mix, and their presence in the concrete shall be cause for rejection of that batch.

7.20.04 Handling

(A) Concrete shall be handled from the mixer to the place of final deposit as rapidly as possible by methods which prevent separation or loss of ingredient. The concrete shall be deposited in the forms as nearly as practicable in its final position to avoid rehandling. Concrete shall be deposited in continuous layers, the thickness of which generally shall not exceed twelve inches (12"). Concrete shall be placed in one continuous operation, except where keyed construction joints are shown on the plans or as approved by the CITY ENGINEER. Delays in excess of thirty (30) minutes may require removal and replacement of that pour, as determined by the CITY INSPECTOR.

(B) Concrete shall be placed in a manner that will avoid segregation and shall not be dropped freely more than five feet (5'). If segregation occurs, the CITY ENGINEER may require the concrete to be removed and replaced at the CONTRACTOR's expense. Necessary hand spreading shall be done with shovels and not with rakes.

(C) Concrete shall be thoroughly consolidated. All concrete shall be consolidated by internal vibration using mechanical vibrating equipment, except that concrete in floor slabs, sidewalks, or curb and gutter, not poured against form linings, shall be either tamped or vibrated. Care shall be taken in vibrating the concrete to vibrate only long enough to bring a continuous film of mortar to the surface. Vibration shall stop before any segregation of the concrete occurs. Mechanical vibrators shall be an approved type as specified in ACI Publication 309, Chapter 5. Vibrators shall not be used to move or spread the concrete. Any evidence of lack of consolidation or over consolidation will be regarded as sufficient reason to require the removal

of the section involved and its replacement with new concrete at no cost to the CITY. The CONTRACTOR shall be responsible for any defects in the quality and appearance of the completed work.

7.20.05 Workability

The consistency of concrete shall be kept uniform for the approved work and shall be checked by means of a slump test. At all times, concrete shall have a consistency such that it can be worked into corners and angles of the forms and around joints, dowels, and tie bars by the construction methods which are being used without excessive spading, segregation, or undue accumulation of water or laitance on the surface. If, through accident, intention, or error in mixing, any concrete that fails to conform to the proportions of the approved mix design, such concrete shall not be incorporated in the work but shall be discarded off the project site as waste material at no cost to the CITY.

Water is only allowed to be added upon delivery prior to discharge within forms or final placement. Water shall only be added up to the amount shown on the concrete ticket based on actual batch information as to not exceed the maximum water cement ratio per the approved mix design. Water will not be allowed to be added to concrete truck once discharging has commenced. Slump tests shall be run and test cylinders cast following the addition of the water. Any expense incurred in excess of ordinary tests will be borne by the CONTRACTOR.

7.20.06 Weather Restrictions

(A) Hot Weather:

Except by written authorization, concrete will not be placed if the temperature of the plastic concrete cannot be maintained at ninety degrees Fahrenheit (90°F) or lower. The placement of concrete in hot weather shall comply with ACI 305.

(B) Cold Weather:

During inclement weather conditions, placing of concrete will be permitted only when the temperature of the concrete placed in the forms will not be less than fifty degrees Fahrenheit (50°F), nor more than ninety degrees Fahrenheit (90°F). To maintain this temperature range, the SUBCONTRACTOR (supplier) shall provide acceptable heating apparatus for heating the aggregates and the water.

Concrete slabs shall not be placed, regardless of temperature conditions, if the supporting ground is frozen or contains frost. Use of salt or other additives to prevent concrete from freezing shall not be allowed. Concrete which has been frozen or failed to have adequate cold weather protection shall be completely removed and replaced as directed by and to the satisfaction of the CITY INSPECTOR.

Concrete may be placed when the air temperature in the shade is at least forty degrees Fahrenheit (40°F) and rising. No concrete shall be placed, regardless of the present temperature, when the weather forecast promises freezing weather before final set of the concrete unless special means of heating and protection are used. Protection against freezing is the CONTRACTOR's responsibility regardless of the weather forecast or climatic conditions at the time of placing.

During cold weather conditions, concrete less than seventy-two (72) hours old shall be protected at a minimum as follows. Maturity meters, to monitor and record time and pavement temperature, shall be installed at the time of placement when the air temperature is expected to fall below forty degrees Fahrenheit (40°F) during the next seventy-two (72) hours or as requested by the Inspector.

Potential methods of cold weather concrete protection include, but are not limited to: Additional layers of plastic or burlap, insulated blankets, heater enclosures, etc.

Cold weather concrete protection must remain in place until the concrete is at least seventy-two (72) hours cured. All finished surfaces shall be protected from defects or scars from cold weather protection.

7.20.07 <u>Jointing</u>

(A) Expansion Joints:

Expansion joint material shall be provided at the following locations and shall be in place prior to the placing of concrete:

1. Between new concrete and existing masonry buildings

2. As shown on the drawings

3. As directed by the CITY ENGINEER

(B) Contraction Joints:

Transverse joints shall be placed at maximum intervals of ten feet (10') to control random cracking. Joints shall be formed, sawed, or tooled to a minimum depth of one-third (1/3) of the total thickness, but no less than 1.5 inches, and shall be a maximum of one-quarter inch (1/4") wide. Tooled or formed joints shall include a rounded radius of one-quarter inch (1/4"). The CITY may require sawed joints based on the type and location of the project.

Contraction joints shall be placed as follows:

1. Not more than ten feet (10') nor less than six feet (6') apart in curb and gutter and combination curb-walk.

2. Not more than the walk width in non-monolithic concrete sidewalk.

3. At least two joints equally spaced at not greater than ten-foot (10') intervals as applicable in driveways.

4. Not more than ten feet (10') in concrete median cover material. Median cover joints shall match adjacent curb and gutter joints whenever possible.

5. As approved and shown on the plans for special concrete structures.

(C) Dowelled Construction Joints:

Construction joints between new and existing concrete, whether the existing concrete is part of the same project or not, shall include dowel bars. Dowel bars shall be epoxy coated and be formed or drilled and grouted into the existing concrete. The dowels shall be #4 bars spaced at eighteen inches (18") on-center or as directed by the Inspector.

(D) Bond-Breaker Joints:

A bond breaker joint consisting of polyethylene sheeting with a minimum thickness of 4 mils and maximum thickness of 6 mils shall be required around the perimeter of concrete median cover material where it contacts curb and gutter as shown in the Standard Details.

7.20.08 Finishing and Curing

In addition to the curing techniques unique to hot and cold weather placement, adequate attention shall be given to finishing and curing the fresh concrete. Exposed faces of curbs and sidewalks shall be finished to true line and grade, as shown on the plans. The surface shall be floated to a smooth, but not slippery, finish. **The addition of surface water or finishing agents to assist in the finishing process is prohibited.** Sidewalk and curb shall be broomed or combed and edged, unless otherwise indicated by the City Engineer. After completion of brooming and before concrete has taken its initial set, all edges in contact with the forms shall be tooled with an edger having a three-eighths-inch (3/8") radius. **No dusting or topping of the surface or sprinkling with water or finishing agents to facilitate finishing will be permitted**.

Immediately following the removal of the forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or are not to be waterproofed. On all surfaces cavities produced by form ties, honeycomb spots, broken corners or edges, and other defects shall either be thoroughly cleaned, moistened with water, and carefully pointed and trued with a mortar consisting of cement and fine aggregate or removed and replaced at the direction of the CITY ENGINEER. The surface shall be left sound,

smooth, even, and uniform in color. Mortar used in pointing shall not be more than thirty (30) minutes old. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

Fresh concrete shall be adequately protected from weather damage and mechanical injury during the curing periods. The selected curing process shall be started as soon as it can be done without injury to the concrete surface. The use of a membrane-curing compound is required. The following curing procedures may be used subject to the approval of the CITY ENGINEER.

(A) Liquid Curing Membrane:

Immediately after the surface water has disappeared from the concrete surface, the liquid membrane curing compound (white pigmented) shall be sprayed under pressure to the concrete surface at a rate not less than one (1) gallon per one-hundred-fifty (150) square feet with a spray nozzle, or nozzles, so it covers the entire pavement with a uniform water-impermeable film. Clear curing compound shall be used in the winter months of October to May and shall be placed under the direct supervisions of the CITY INSPECTOR. If the forms are removed within seven (7) days, the exposed sides and edges shall be sprayed in the above-described manner or the backfill completed immediately.

(B) Plastic Sheet Curing:

As soon after the completion of the finishing operation as the concrete has set sufficiently to prevent marring of the surface, the top surface and sides shall be entirely covered with plastic sheet materials. The plastic sheet as prepared for use shall have such dimensions that each unit as laid will extend beyond the edges of the concrete at least twice the thickness of the concrete. The units as used shall be lapped at least twelve inches (12"), and the laps of plastic sheet shall be secure such that they do not open up or separate. The plastic shall be placed and weighted so it remains in contact with the surface covered, curing the entire curing period of seven (7) days. The placement of plastic sheets shall not mar or leave defects in the concrete surface. Curing compound shall be applied to the concrete within 24 hours. Plastic sheet curing will be allowed only during inclement weather as approved by the CITY INSPECTOR.

(C) Insulation Pad:

Insulation pads or other thermal devices may be used to protect concrete in cold weather.

(D) Wax base and resin base solutions shall not be used if linseed oil protection is to be applied to the concrete surface. If linseed oil protection is to be utilized, the method of curing shall be either linseed

oil base curing compound, wet burlap, plastic sheet, or waterproof paper curing.

7.20.09 Testing of Concrete

The requirements of Table 7.20.01 shall apply to testing services for all concrete curb and gutter, sidewalk, slope paving, retaining walls, structures, and for all miscellaneous concrete testing. Testing for concrete pavement shall be in accordance with Table 7.20.02.

The CONTRACTOR shall furnish the concrete necessary for casting test cylinders. The number of cylinders and tests shall be as follows:

TABLE 7.20.01
Test Requirements for Curb and Gutter, Sidewalk, Slope Paving, Retaining Walls, Structures and Miscellaneous Concrete

Type of Test	Frequency
Slump	1 per set of cylinders and as often as needed for quality control
Air Content	1 per set of cylinders and as often as needed for quality control
Yield and Cement Factor	1 per set of cylinders and as often as needed for quality control
Compressive Strength*	1 set of five (5) cylinders per 100 cubic yards or major fraction thereof on each day concrete is placed with standard breaks of the cylinders at: 2 @ 7 days, 2 @ 28 days and 1 held or as specified by the CITY INSPECTOR. Additional field cylinders may be required to determine early opening strength.

*Alternative compressive strength methods such as maturity meters shall be approved by the CITY ENGINEER in advance in writing.

TABLE 7.20.02
Test Requirements for Concrete Pavement

Type of Test	Frequency
Gradation (aggregate)	1 per 2500 sq. yard or fraction thereof for each size aggregate
Moisture Content, fine aggregate	1 per day or as often as needed for quality control
Moisture Content, coarse aggregate	1 per day minimum where moisture content is +0.5 percent from SSD condition
Slump	1 per set of cylinders and as often as needed for quality control
Air Content	1 per set of cylinders and as often as needed for quality control
Yield and Cement Factor	1 per set of cylinders and as often as needed for quality control
Compressive Strength	1 set of four (4) cylinders per 5000 sq. yards or major fraction thereof on each day pavement is placed, with two (2) cylinders to be field-cured. One additional set shall be made if the CONTRACTOR intends to open early for traffic
Thickness	1 per 1250 linear feet each traffic lane on freshly finished concrete and as often as needed for quality control

The degree and frequencies of all concrete testing beyond normal specified frequencies, if necessary to assure quality control, shall be determined by the CITY ENGINEER at the time of concrete construction. All concrete testing necessary shall be paid for by the CONTRACTOR/ DEVELOPER.

7.20.10 Repairs

After stripping of the forms, if any concrete is found to be not formed as shown on the drawings or is out of alignment or level or shows a defective surface, it shall be considered as not conforming with the intent of these STANDARDS AND SPECIFICATIONS and shall be removed and replaced by the CONTRACTOR at his expense unless the CITY ENGINEER gives written permission to patch the defective area. In this case, patching shall be done as described in the following paragraphs. Defects that require replacement or repair are those that contain honeycomb, damage due to stripping of forms, loose pieces of concrete, bolt holes, tie-rod holes, uneven or excessive ridges at form joints, and bulges due to movement of the forms and other deficiencies noted in Section 12.04.06. Ridges and bulges shall be removed by grinding. Honeycombed and other defective concrete that does not affect the integrity of the structure shall be chipped out and the vacated areas shall be filled in a manner acceptable to the CITY ENGINEER. The repaired area shall be patched with a non-shrink, non-metallic grout with a minimum compressive strength of five thousand (5000) psi in twenty-eight (28) days. All repair areas treated with

an epoxy bonding agent shall have the approval of the CITY ENGINEER before the repair filling is placed.

Bolt holes, tie-rod holes, and minor imperfections as approved by the CITY ENGINEER shall be filled with dry-patching mortar composed of one (1) part Portland cement to two (2) parts of regular concrete sand (volume measurement) and only enough water so that after the ingredients are mixed thoroughly the mortar will stick together on being molded. Mortar repairs shall be placed in layers and thoroughly compacted by suitable tools. Care shall be taken in filling rod and bolt holes so that the entire depth of the hole is completely filled with compacted mortar. The mortar mix proportions described above are approximate.

Those areas with excessive deficiencies as determined by the CITY INSPECTOR shall be removed and replaced at no cost to the CITY. Where repairs are made in existing sidewalks, all edges of the old sidewalk allowed to remain shall be saw-cut to a minimum depth of two inches (2"). No rough edges will be permitted where new construction joins the old section. Unless directed by the CITY INSPECTOR, no section less than five feet (5') in length shall be placed or left in place. Where new sidewalk construction abuts existing sidewalks, the work shall be accomplished so that there is no abrupt change in grade between the old section and the new work.

7.30.00 MATERIAL SPECIFICATIONS

7.31.00 CONCRETE MIX DESIGN

Concrete shall be classed according to CDOT Table 601-1. Project application of the different concrete classes shall be as follows:

Concrete Sidewalk	--	Class B
Concrete Curb and Gutter	--	Class B
Concrete Structures	--	Class D
Concrete Pavement	--	Class P
Precast Products	--	Refer to Materials Section of appropriate chapter

7.32.00 CONCRETE MATERIALS

Concrete shall be composed of Portland cement and aggregate and water and shall be reinforced with steel bars, steel strands, or steel-wire fabric where required. No admixture other than air-entraining agents shall be used without written permission of the CITY ENGINEER.

7.32.01 Cement

Portland Cement shall conform to the requirements of the following specifications for the type specified or permitted:

Type	Specification
Portland Cement, Type I, II, III	ASTM C 150, AASHTO M 85
Air-Entraining Portland Cement	AASHTO M 134
Fly Ash, Type C/F	ASTM C 618
Masonry Cement	AASHTO M 150

In general, Type II cement shall be used in concrete which will be in contact with the soil unless otherwise allowed or directed by the CITY ENGINEER. Unless otherwise permitted by the CITY ENGINEER, the product of only one (1) mill of any one brand and type of Portland cement shall be used on the project, except for reduction of any excessive air entrainment, where air-entrainment cement is used. The CONTRACTOR shall provide suitable means of storing and protecting the cement against dampness. Cement which for any reason has become partially set or which contains lumps of caked cement shall be rejected. Cement salvaged from discarded or used bags shall not be used.

7.32.02 Aggregate

Aggregate for concrete shall be proportioned in conformance with Table 7.32.01 of these STANDARDS AND SPECIFICATIONS.

(A) Coarse Aggregate for concrete other than pavement:

The coarse aggregate shall consist of broken stone or gravel composed of clean, hard, tough, and durable stone and shall be free from soft, thin, elongated, or laminated pieces, disintegrated stone, clay, loam, vegetable, or other deleterious matter. Coarse aggregate for concrete shall conform to the requirements of AASHTO M 80, except that the percentage of wear shall not exceed forty-five (45) when tested in accordance with AASHTO T 96.

(B) Coarse Aggregate for concrete pavement:

Coarse aggregate shall conform to the requirement of AASHTO M 80, latest edition, except that the percentage of wear shall not exceed forty-five (45) when tested in accordance with AASHTO T 96. Coarse aggregate shall conform to the grading in Table 7.32.01. Sizes 357 and 467 shall each be furnished in two separate sizes and combined in the plant in the proportions necessary to conform to the grading requirements. Size 357 is a combination of No. 3 and No. 57, and Size No. 467 is a combination of No. 4 and No. 67.

(C) Fine Aggregate for concrete other than pavement:

Fine aggregate shall be composed of clean, hard, durable, uncoated particles of sand, free from injurious amounts of clay, dust, soft or flaky particles, loam, shale, alkali, organic matter, or other deleterious matter. Fine aggregate shall be well-graded from course to fine and, when tested by means of laboratory sieves, shall meet the grading requirements of Table 7.32.01 of these STANDARDS AND SPECIFICATIONS.

(D) Fine Aggregate for concrete pavement:

Fine aggregate for shall conform to the requirements of AASHTO M 6, latest edition. The amount of deleterious substances removable by elutriation shall not exceed three percent (3%) by dry weight of fine aggregate when tested in accordance with AASHTO T 11 unless otherwise specified. The minimum sand equivalent, as tested in accordance with AASHTO T 176 shall be eighty (80) unless otherwise specified. The fineness modules shall not be less than 2.50 nor greater than 3.50 unless otherwise approved by the CITY ENGINEER.

TABLE 7.32.01
Concrete Aggregate Gradation Table
Percentages Passing Designated Sieves and Nominal Size Designation

Sieve Size	No. 3*	No. 4*	No. 6	No. 7	No. 8	No. 57*	No. 67*	No. 357*	No. 467*	AASHTO M6
	2" to 1"	1-1/2" to 3/4"	3/4" to 3/8"	1/2" to #4	3/8" to #8	1" to #4	3/4" to #4	2" to #4	1-1/2" to #4	#4 to #100
2-1/2"	100								100	
2"	90-100	100							95-100	
1-1/2"	35-70	90-100				100				
1"	0-15	20-55	100			95-100	100	35-70		
3/4"		0-15	90-100	100			90-100		35-70	
1/2"	0-5		20-55	90-100	100	25-60		10-30		
3/8"		0-5	0-15	40-70	85-100		20-55		10-30	100
#4			0-5	0-15	10-30	0-10	0-10	0-5	0-5	95-100
#8				0-5	0-10	0-5	0-5			
#16					0-5					45-80
#50										10-30
#100										2-10

* Additional primary gradings may be permitted when produced on the project provided the theoretical combination meets the specifications for combined aggregate sizes. Size No. 357 is a combination of No. 3 and No. 57. Size No. 467 is a combination of No. 4 and No.67

7.32.03 Water

Water used in mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetation, organic matter, or other substance injurious to the finished product. Water shall be tested in accordance with and shall meet the suggested requirements of AASHTO T 26. Water known to be of potable quality may be used without test. Where the source of water is relatively shallow, the intake shall be so enclosed to exclude silt, mud, grass, or other foreign materials.

7.32.04 Admixtures

The CONTRACTOR shall use air-entraining admixtures for all concrete that will have exposed surfaces. The CONTRACTOR may elect to use another admixture provided the admixture is specifically approved by the CITY ENGINEER. Documentary evidence of acceptability will be required when new or unknown admixtures are proposed for use. Air-entraining admixtures shall conform to the requirements of ASTM C 260.

Air-entraining admixtures for concrete pavement shall conform to the requirements of AASHTO M 154, latest edition, and ASTM C 260, latest edition.

Chemical admixtures, if permitted by the CITY ENGINEER for concrete, shall conform to the requirements of AASHTO M 194, latest edition.

Admixtures which have been frozen will be rejected.

7.32.05 Fly Ash

The CONTRACTOR shall use fly ash for all concrete in the RIGHT-OF-WAY, and it shall conform to the requirements of ASTM C 618, Table 1-A, latest edition, for Class C or Class F. (The pozzolanic activity index shall be 85 for Class C and Class F, Fly Ash.) Class C fly ash will not be permitted where sulfate-resistant cement is required.

The CONTRACTOR shall notify the CITY ENGINEER of the source of fly ash for review before using in the project. The fly ash shall be subject to sampling and testing by agents of the CITY. Test results that do not meet the physical and chemical requirements may result in the suspension of the use of fly ash until the necessary corrections have been taken to ensure that the material meets specifications. All costs associated with possible testing of fly ash by the CITY, which do not meet these specifications, shall be paid by the CONTRACTOR. The fly ash for use on the project shall have been tested by the CONTRACTOR for compliance with these specifications and submitted to the CITY ENGINEER for review prior to its use in the project.

7.33.00 REINFORCING STEEL

Reinforcing steel shall conform to the requirements of the following specifications:

(A)	Deformed and plain billet-steel bars for concrete reinforcement	ASTM A615
(B)	Axle-steel deformed and plain bars for concrete reinforcement	ASTM A996
(C)	Fabricated steel bar or rod mats for concrete reinforcement	ASTM A706
(D)	Welded steel-wire fabric plain for concrete reinforcement	AASHTO M 55
(E)	Welded deformed steel wire fabric for concrete reinforcement	AASHTO M 221
(F)	Epoxy coated rebar	AASHTO A 775

Unless otherwise designated, bars conforming to ASTM A615 & ASTM A996 shall be furnished in Grade 60 for No. 5 bars and larger and Grade 40 or 60 for bars smaller

than No. 5. In ASTM A184, bar material conforming to ASTM A616 will not be permitted.

7.34.00 CURING MATERIALS

7.34.01 General

(A) Sheet materials for curing concrete shall conform to AASHTO M 171.

(B) Burlap cloth made from Jute or Keaff shall conform to AASHTO M 182.

(C) Straw used for curing shall consist of threshed straw or oats, barley, wheat, or rye. Clean field or marsh hay may be substituted when approved by the CITY ENGINEER. Old, dry straw or hay which breaks readily in the spreading process will not be permitted.

7.34.02 Liquid Curing Compound (Pigmented)

Liquid white-pigmented membrane-forming compounds shall conform to AASHTO M 148.

7.34.03 Liquid Curing Compound (Clear)

During the winter months of October to May, clear curing compound shall be utilized. The compound shall meet ASTM C 1315 Type I, Class A (clear, non-yellowing). The compound must be an acrylic copolymer type, non-freezing solvent based, with a minimum of 25% solids content. Compound must be VOC compliant in accordance with EPA 40 CFR Part 59. The final gloss appearance will serve as proof of application.

The CONTRACTOR shall use a sealer that when applied according to manufacturer's recommendations will not adversely affect the skid resistance of the pavement. The use of cure-sealer shall not be a substitute for best cold weather curing practices according to ACI 308.

7.35.00 FORM WORK

7.35.01 Forms for Structures, Curb and Sidewalks

Whenever necessary, forms shall be used to confine the concrete and shape it to the required lines. Forms shall have sufficient strength to withstand, without deformation, the pressure resulting from placement and vibration of the concrete. Forms shall be constructed so that the finished concrete will conform to the shapes, lines, grades, and dimensions indicated on the approved plans. Any form which is not clean and has not had the surface prepared with a commercial form oil that will effectively prevent bonding and that will stain or soften concrete surfaces shall not be used. Plywood forms, plastic coated plywood forms, or steel forms shall be used for all surfaces requiring forming which are exposed to view, whether inside or outside any structure. Forms shall be true and straight and free of any defects that would cause imperfections in the final surface. Surfaces against backfilled earth, interior surfaces, of covered

channels, or other places permanently obscured from view may be formed with forms having substandard surfaces.

7.35.02 Removal of Forms

The forms for any portion of the structure shall not be removed until the concrete is strong enough to withstand damage when the forms are removed.

Unless specified in the plans, forms shall remain in place for members that resist dead load bending until concrete has reached a compressive strength of at least eighty percent (80%) of the required twenty-eight (28) day strength, $0.80f'_c$. Forms for columns shall remain in place until concrete has reached a compressive strength of at least one thousand (1,000) psi. Forms for sides of beams, walls or other members that do not resist dead load bending shall remain in place until concrete has reached a compressive strength of at least five hundred (500) psi.

Forms and supports for cast-in-place concrete box culverts (CBCs) shall not be removed until the concrete compressive strength exceeds $0.6f'_c$ for CBCs with spans up to and including twelve feet (12'), and $0.67f'_c$ for CBCs with spans exceeding twelve feet (12') but not larger than twenty feet (20'). Forms for CBCs with spans larger than twenty feet (20') shall not be removed until after all concrete has been placed in all spans and has attained a compressive strength of at least $0.80f'_c$. Backfill shall not occur until the top slab has attained a compressive strength of $1.0f'_c$.

Concrete compressive strength shall be determined by maturity meters in accordance with CDOT CP 69. At the Pre-Pour Conference, the CONTRACTOR shall submit the location where maturity meters will be placed.

The CONTRACTOR shall provide maturity meters and all necessary wires and connectors. The CONTRACTOR shall be responsible for the placement and maintenance of the maturity meter and wire. At a minimum a maturity meter shall be placed at the mid-span of beams and at support locations. Placement shall be as directed by the CITY ENGINEER.

For structures with multiple maturity meters, the lowest compressive strength shall determine when the forms can be removed.

Acceptance cylinders shall not be used for determining compressive strength to remove forms.
When field operations are controlled by maturity meters, the removal of forms, supports and housing and the discontinuance of heating and curing may begin when the concrete is found to have the required compressive strength.

Forms for barrier, railing, or curbs may be removed at the convenience of the CONTRACTOR after the concrete has hardened.

All forms shall be removed except permanent steel bridge deck forms and forms used to support hollow abutments or hollow piers when no permanent access is available into the cells. When permanent access is provided into box

girders, all interior forms, falsework, and loose material shall be removed, and the inside of box girders shall be cleaned with an industrial vacuum.

7.35.03 Forms for Concrete Pavement

Straight side forms shall be made of a metal having a thickness of not less than seven-thirty-seconds of an inch (7/32") and shall be furnished in sections not less than ten feet (10') in length. Forms shall have a depth equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width equal to or greater than the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of one-hundred-foot (100') radius or less. Flexible or curved forms shall be of a design acceptable to the CITY ENGINEER. Forms shall be provided with adequate devices for secure setting so 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. Forms with battered top surfaces and bent, twisted, or broken forms shall be removed from the site. Repaired forms shall not be used until accepted by the CITY ENGINEER. 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 (2000) square yards. The top face of the form shall not vary from a true plane more than one-eighth inch (1/8") in ten feet (10'), and the upstanding leg shall not vary more than one-quarter inch (1/4"). The forms shall contain provisions for locking the ends of abutting form sections together tightly and for secure setting.

Forms for bridge approach slabs or for pavement areas with irregular dimensions shall be made of metal or straight, sound timber. Forms shall be free from warp and of sufficient strength to resist springing out of shape. Forms shall be staked securely to line and grade to the satisfaction of the CITY ENGINEER. All mortar and dirt shall be removed from the forms that have been previously used.

Commercial quality, colorless mineral oil, free of kerosene and of a suitable viscosity, shall be used as form oil.

7.35.04 Slip-Formed Concrete Pavement

Slip-form paving equipment shall be equipped with traveling side forms of sufficient dimensions, shape, and strength to support the concrete pavement laterally for a sufficient length of time during placement to produce pavement of the required cross section.

No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation shall not exceed 0.04 foot from the designed alignment or as established by the CITY ENGINEER. All forms shall be cleaned thoroughly each time they are used and coated with a light oil as often as necessary to prevent the concrete pavement from adhering to them.

7.36.00 JOINTING MATERIAL

7.36.01 General Joint Materials

Joint materials will conform to specifications according to type as follows:

(A)	Concrete joint sealer, hot-poured elastic	AASHTO M 173
(B)	Performed expansion joint filler (bituminous type)	AASHTO M 33
(C)	Performed expansion joint fillers (non-extruding and resilient bit)	AASHTO M 213
(D)	Self-Leveling joint sealant (Sika Concrete Sealer)	ASTM C920
(E)	Bond-breaker joint (plastic sheeting)	ASTM C171

7.36.02 Concrete Pavement Joint Materials

(A) **Joint Sealing Compound:**

Material for filling all types of pavement joints shall be a hot-poured elastomeric-type sealant specifically manufactured for sealing joints in concrete. The material shall not crack or break its bond when exposed to a temperature of zero degrees Fahrenheit (0°F). Joint sealing compounds shall meet the requirements of ASTM D 6690.

(B) **Expansion Joints:**

Expansion joint material shall be non-extruding and resilient bituminous types and shall conform to AASHTO M 213. The filler shall be furnished in a single piece for the depth and thickness required for the joint.

(C) **Cold Joint Sealer:**

Cold-applied joint sealer material for concrete slab joints shall conform to the requirements of ASTM D 5893 and be on the CDOT Approved Products List for concrete joint sealers.

(D) **Steel Spacers:**

Metal chairs used to support longitudinal, tie, or reinforcing bar shall be channel shaped, pressed out of sheet steel of not less than twelve (12) gauge (U.S. Standard) metal.

(E) **Dowel Baskets:**

Pre-formed, continuous dowel expansion joint material supports shall be eighteen (18) gauge (U.S. Standard) metal or three- (3) gauge wire chairs with ten- (10) gauge tie wires or heavier spaced no further than eighteen inches (18") along the axis of the expansion joint.

(F) **Expansion Tubes:**

Metal dowel caps or tubes shall be manufactured from thirty-two- (32) gauge sheet metal or heavier, shall not be less than five inches (5") in length, shall be indented to provide a limiting stop for the dowel bars, and shall provide unobstructed expansion space of not less than one inch (1") to permit movement of the dowel bar. The inside diameter shall be one-sixteenth inch (1/16") larger than the diameter of the specified dowel bars and the closed end shall be watertight. Caps made from bituminous-treated paper or other similar material shall not be used.

(G) **Epoxy:**

Epoxy used for bonding new or wet concrete to old concrete shall be an acceptable product and shall be of the type specifically intended for bonding wet concrete to existing concrete and shall be submitted to the CITY ENGINEER for review prior to use.

7.37.00 BATCHING AND MIXING

7.37.01 General

All concrete shall be thoroughly mixed in a batch mixer of an approved type and capacity for a period of not less than two (2) minutes after all the materials, including the water, have been placed in the drum. During the period of mixing, the drum shall be operated at the speed specified by the manufacturer of the equipment. The entire contents of the mixer shall be discharged before recharge, and the mixer shall be cleaned frequently. The concrete shall be mixed only in such quantities that are required for immediate use. No retempering of concrete will be permitted. Hand-mixed concrete will not be permitted except by written approval of the CITY ENGINEER and then in only very small quantities or in case of an emergency.

7.37.02 Proportioning the Mix

Proportioning the dry constituents of all concrete mixtures shall be accomplished by weighing. The supplier shall provide adequate and accurate scales for this work. There shall be no variance permitted in the minimum cement factor (sacks per cubic yard) as specified for the classes of concrete. The total quantity of mixing water per sack of cement, including free water in the aggregate, shall not exceed the minimum specified herein. The supplier shall be responsible for developing the proper proportions of aggregates, cement, and water that will conform to the various requirements of these STANDARDS AND SPECIFICATIONS.

7.37.03 Ready-Mixed Concrete

The use of ready-mixed concrete in no way relieves the CONTRACTOR or DEVELOPER of the responsibility for proportion, mix, delivery, or placement of concrete. All concrete shall conform to all requirements of these STANDARDS AND SPECIFICATIONS and ASTM C 94 and AASHTO M 157.

The CITY shall have free access to the mixing plant at all times. The organization supplying the concrete shall have sufficient plant and transportation facilities to assure continuous delivery of the concrete at the required rate. The CONTRACTOR shall collect delivery or batch tickets from the driver for all concrete used on the project and deliver them to the CITY ENGINEER. Batch tickets shall provide the following information:

(A) Supplier's name and date
(B) Truck number
(C) Project number and location
(D) Concrete class designation
(E) Cubic yards batched
(F) Time batched
(G) DOH mix design number
(H) Type, brand, and amount of cement and fly ash
(I) Brand and amount of any admixture
(J) Weights of fine and coarse aggregates
(K) Moisture content of fine and coarse aggregates
(L) Gallons of batch water (including ice)
(M) Gallons of water added by truck operator.
(N) Allowable water to add

Provide the following titles with blank space to record information:

(O) Discharge time
(P) Water-cement ratio
(Q) Air content
(R) Slump
(S) Revolutions

TABLE OF CONTENTS

CHAPTER 8

TRAFFIC

Page

8.00.00 INTRODUCTION 8-1

8.01.00 GENERAL 8-1
8.02.00 GLOSSARY OF TERMS 8-1

8.10.00 DESIGN STANDARDS 8-3

8.10.01 Responsibilities for Traffic Studies 8-3
8.10.02 Traffic Study Format 8-5
8.10.03 Summary of Typical Study Contents 8-11
8.11.00 ACCESS REQUIREMENTS AND CRITERIA 8-12
8.11.01 Definitions of Terms 8-13
8.11.02 General Requirements 8-15
8.11.03 General 8-17
8.11.04 State Highways 8-17
8.11.05 Major Arterials 8-17
8.11.06 Minor Arterials 8-19
8.11.07 Major and Minor Collectors 8-19
8.11.08 Local Streets 8-19
8.11.09 Basic Principles for Curb Openings and Driveways 8-19
8.11.10 Control Dimensions 8-21
8.12.00 PARKING 8-22
8.12.01 Regular Parking 8-22
8.12.02 Compact Parking 8-25
8.12.03 Signing 8-25
8.12.04 Maximum Allowable Grades Permitted in Parking Lots 8-25
8.12.05 Accessible Parking Posting 8-26
8.12.06 Parking Structures 8-26
8.13.00 BICYCLE LANES 8-26
8.13.01 General Requirements 8-26
8.13.02 Bike Lane Widths and Markings 8-26
8.13.03 Buffered Bike Lanes 8-27
8.13.04 Shared Bike Lanes 8-27
8.13.05 Bike Lanes and Right Turn Lanes 8-27
8.13.06 Bike Racks 8-27
8.14.00 CROSSWALKS 8-28
8.14.01 General Requirements 8-28
8.14.02 School Crosswalks 8-28
8.14.03 Raised Crosswalks 8-28

8.20.00 CONSTRUCTION STANDARDS 8-28

8.21.00 TRAFFIC SIGNALS 8-28
8.21.01 General Requirements 8-28
8.21.02 Traffic Control and Street Closure 8-28

8.21.03 Intersection Power *8-29*
8.21.04 Equipment Salvage *8-29*
8.21.05 Existing Traffic Signals *8-29*
8.21.06 Signal Heads *8-29*
8.21.07 Field Location *8-29*
8.21.08 Utilities *8-30*
8.22.00 REGULATIONS AND CODE 8-30
8.23.00 SUBMITTAL REQUIREMENTS 8-30
8.24.00 BORING, EXCAVATING AND BACKFILLING 8-30
8.25.00 REMOVING AND REPLACING IMPROVEMENTS 8-31
8.26.00 UNDERGROUND FACILITIES 8-31
8.26.01 Foundations *8-31*
8.26.02 Conduit *8-32*
8.26.03 Pull Boxes *8-33*
8.26.04 Detector Loop Wire Installation *8-34*
8.26.05 Conductor and Cable *8-34*
8.26.06 Bonding and Grounding *8-37*
8.26.07 Maintenance *8-37*
8.26.08 Field Testing *8-38*
8.27.00 TRAFFIC SIGNING AND PAVEMENT MARKINGS 8-39
8.27.01 General *8-39*
8.27.02 Traffic Control Devices on Public Property *8-39*
8.27.03 Traffic Control Devices on Private Property *8-39*
8.27.04 Pavement Markings *8-39*
8.28.00 TRAFFIC CONTROL IN CONSTRUCTION AREAS 8-40
8.28.01 General *8-40*
8.28.02 Time of Submittal *8-40*
8.28.03 Scope of Construction Traffic Control Plan *8-41*
8.28.04 Elements of Construction Traffic Control Plan *8-41*
8.28.05 Basis for Construction Traffic Control Plan *8-41*
8.28.06 Restriction, Regulations, and Opportunities *8-42*
8.28.07 Approval *8-42*
8.28.08 Modifications *8-42*

8.30.00 MATERIAL SPECIFICATIONS 8-42

8.31.00 SIGNAL HEADS 8-42
8.31.01 Traffic Signal Unit Specifications *8-42*
8.31.02 Pedestrian Signal Units *8-43*
8.31.03 Backplates *8-43*
8.32.00 ELECTRICAL CABLE 8-44
8.32.01 Signal Cable *8-44*
8.32.02 Interconnect Cable *8-44*
8.32.03 Loop Wire *8-44*
8.32.04 Pedestrian Push-Button Cable *8-44*
8.32.05 Loop Lead-In Cable *8-44*
8.32.06 Ground *8-45*
8.32.07 Optical Detector Lead-In Cable *8-45*
8.33.00 VEHICLE DETECTORS 8-45
8.33.01 General *8-45*
8.34.00 EMERGENCY VEHICLE DETECTORS 8-47

8.35.00 DETECTORS (PEDESTRIAN PUSH-BUTTON) 8-48
8.35.01 General *8-48*
8.36.00 TRAFFIC SIGNAL POLES, PEDESTALS, AND MAST ARMS 8-48
8.36.01 Submittal Requirements *8-48*
8.36.02 Traffic Signal Poles with Mast Arms *8-48*
8.36.03 Finishes *8-50*
8.36.04 Fianl Steps *8-50*
8.37.00 CONTROLLER CABINET 8-50
8.37.01 General *8-50*
8.37.02 Cabinet Assembly Profile Detail *8-50*
8.37.03 Cabinet Design and Construction *8-51*
8.37.04 Terminals and Facilities *8-53*
8.37.05 Main Panel Design and Construction *8-54*
8.37.06 Power Panel Design and Construction *8-56*
8.37.07 Power Bus Assembly - SDLC Hub Assembly *8-57*
8.37.08 Auxiliary Cabinet Equipment *8-57*
8.37.09 Vehicle Detection *8-58*
8.37.10 Cabinet Test Switch Panel and Police Switch Panel *8-59*
8.37.11 Auxiliary Devices *8-60*
8.37.12 Auxiliary Cabinet Devices - To Be Provided Per Customer Request *8-61*
8.37.13 Testing and Warranty *8-62*
8.38.00 ACTUATED CONTROLLERS 8-62
8.38.01 General *8-62*
8.39.00 MISCELLANEOUS HARDWARE 8-64
8.39.01 General *8-64*
8.40.00 INSTRUCTIONS AND WIRING DIAGRAMS 8-64
8.41.00 SIGN SPECIFICATIONS 8-64
8.41.01 Sign Face Materials *8-64*
8.41.02 Sign Post Materials *8-64*
8.41.03 Fire Lane Sign Specifications *8-64*
8.42.00 ILLUMINDATED STREET NAME SIGNS 8-64
8.42.01 General *8-64*
8.42.02 Sign Material *8-65*
8.42.03 Lettering *8-65*
8.42.04 Colors *8-65*
8.42.05 Installation *8-66*
8.42.06 Wiring *8-66*
8.42.07 Warranty *8-66*

CHAPTER 8
TRAFFIC

8.00.00 INTRODUCTION

8.01.00 GENERAL

The standards contained in this Chapter regulate all improvements and private work to be dedicated to the public and accepted by the City and all work within the RIGHT-OF-WAY. They are intended to provide for adequate, coordinated, modern development with required facilities to serve and protect the users of the community.

The adopted Westminster Transportation & Mobility Plan (2021) will also be referenced to guide the planning for and implementation of multimodal transportation improvements in Westminster.

The standards in this chapter apply to new developments which are not constrained by already existing improvements. This chapter is not to be applied without qualification to in-fill development. In-fill development in an urban area is often constrained by existing improvements. In-fill developments shall be required to conform to these STANDARDS AND SPECIFICATIONS. Any modifications of these STANDARDS AND SPECIFICATIONS shall be approved by the CITY ENGINEER.

8.02.00 GLOSSARY OF TERMS

AASHTO -- American Association of State Highway and Transportation Officials

Access -- Driveway or other point of access such as a street, road, or highway that connects to the general street system. Where two public roadways intersect, the secondary roadway shall be the access.

Approach -- The portion of an intersection leg which is used by traffic approaching the intersection.

Average Daily Traffic (ADT) -- The total bi-directional volume of traffic passing through a given point during a given time period, divided by the number of days in that time period.

Band Width -- The time in seconds or the percent of cycle between a pair of parallel lines which delineate progressive movement on a time-space diagram. It is a quantitative measurement of through traffic capacity provided by signal progression.

Capacity -- The maximum number of vehicles that have a reasonable expectation of passing over a given roadway or section of roadway in one direction during a given time period under prevailing roadway and traffic conditions.

Critical Volume -- A volume (or combination of volumes) for a given street which produces the greatest utilization of capacity for that street in terms of passenger cars or mixed vehicles per hour.

Cycle Time -- The time period in seconds required for one complete sequence of signal indications.

Deceleration Lane -- A speed change lane, including tapered areas, for the purpose of enabling a vehicle that is to make an exit turn from a roadway to slow to a safe turning speed after it has left the main stream of faster-moving traffic.

Delay -- Stopped time per approach vehicle in seconds per vehicle.

Design Hour Volume (DHV) -- Hourly traffic volume used for street design and capacity analysis, usually one or more peak hours during a twenty-four (24) hour period.

Design Speed -- Five to ten miles per hour (5-10 mph) above the proposed or desired speed limit of the facility under design for roadways with a collector or higher classification. Local roadways have a design speed that is the same as the posted speed limit.

Design Vehicle -- Developments intended for public use must be designed for the following types of vehicles:

Residential (excluding single-family or duplex)	SU30
Commercial Uses	WB40
Industrial Uses	WB50

For public streets, the following design vehicles must be used:

Commercial/Multi-Family Locals & Minor Collectors	SU30
Major Collectors	WB40
Arterials	WB50

Definitions for the above vehicle types are found in AASHTO Geometric Highway Design Standards.

Divided Highway -- A highway with separated roadways for traffic in opposite directions, such separation being indicated by depressed dividing strips, raised curbs, traffic islands, other physical separations, or by standard pavement markings and other traffic control devices.

Fire Trucks -- Must be considered as a WB40 truck with a minimum forty-five-foot (45') radius for design purposes.

Flowline -- The transition point between the gutter and the face of the curb. For a cross or valley pan, it is the center of the pan.

Grade -- Rate or percent of slope, either ascending or descending from or along the highway. It is usually measured along the centerline of the highway or access.

Green Time -- The length of a green phase plus its change interval, in seconds.

Hourly Volume -- The number of (mixed) vehicles that pass over a given section of a lane or roadway during a time period of one (1) hour.

Level of Service (LOS) -- A measure of the mobility characteristics of an intersection as determined by vehicle delay and a secondary factor, the volume/capacity ratio.

MUTCD -- Manual on Uniform Traffic Control Devices and the Colorado Supplement (latest version).

Sight Distance -- The length of roadway ahead visible to the driver. The minimum sight distance available should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path.

Signal Progression -- Progressive movement of traffic at a planned rate of speed through adjacent signalized locations within a traffic control system without stopping.

Speed Change Lane -- A separate lane for the purpose of enabling a vehicle entering or leaving a roadway to increase (acceleration lane) or decrease (deceleration lane) its speed to a rate at which it can more safely merge or diverge with through traffic.

Stopping Sight Distance -- The distance traveled by the vehicle from the instant the driver of a vehicle sights an object necessitating a stop to the instant the brakes are applied and the distance required to stop the vehicle from the instant brake application begins.

Storage Lane -- Additional lane footage added to a deceleration lane to store the maximum number of vehicles likely to accumulate during a critical period without interfering with the through lanes.

Time Space Diagram -- A chart on which the distance between signals and signal timing is plotted against time. The chart, when completed, indicates signal progression band widths and speed of traffic.

8.10.00 DESIGN STANDARDS

8.10.01 Responsibilities for Traffic Studies

Traffic studies may be required by the CITY in order to adequately assess the impacts of a development proposal on the existing and/or planned street system. The primary responsibility for assessing the traffic impacts associated with a proposed development shall rest with the developer, with the CITY serving in a review capacity.

Unless waived by the TRAFFIC ENGINEER, a written study meeting the criteria contained in this chapter shall be required for a development proposal when trip generation during the AM or PM peak hour is expected to exceed one hundred (100) vehicles, as determined by the TRAFFIC ENGINEER. This study shall be the

responsibility of the applicant and shall be prepared by a Professional Engineer registered in the State of Colorado, with adequate experience in transportation engineering. Upon submission of a draft traffic study, the TRAFFIC ENGINEER will review the study data sources, methods, and findings. Comments shall be provided in a written form. The developer and the project engineer will then have an opportunity to incorporate necessary revisions prior to submitting a final report. All studies shall be approved by the TRAFFIC ENGINEER before acceptance. The following submittals will require traffic studies:

(A) A rezoning application or an application for annexation into the CITY.

(B) A preliminary map or final plat if the property has already been rezoned for the proposed use and no traffic study was required for the rezoning, or the land use assumptions at the time of platting will result in trip generation increasing by more than fifteen percent (15%) compared to trip generation estimates made for the traffic study at the time of rezoning.

(C) Prior to issuance of a building permit, if the property has already been zoned/platted and no previous traffic study less than two (2) years old exists.

(D) The applicant shall be required to submit a new traffic study if, after submitting the original traffic study for any of the above submittals, the land use intensity is increased by more than fifteen percent (15%), or the land use is changed so that trip generation is increased by more than fifteen percent (15%).

All previous traffic studies relating to the development that are more than two (2) years old shall be updated, unless the TRAFFIC ENGINEER determines that conditions have not changed significantly. Where access points are not defined or a site plan is not available at the time the traffic study is prepared, additional traffic analysis may be required when a site plan becomes available or the access points are defined.

The applicant will be notified at the pre-application stage if a traffic study will be required, provided sufficient information is available for the CITY to determine whether the trip generation criterion has been met. If insufficient information is available but the property appears to involve a sufficiently intense land use, the applicant will be informed that a traffic study is required.

Transportation consultants are required to discuss projects with the TRAFFIC ENGINEER prior to starting the study. As a minimum, topics for possible discussion at such meeting shall include trip generation, directional distribution of traffic, trip assignment, definition of the study area, intersections requiring capacity/level of service analysis, and methods for projecting build-out volume. This will provide a firm base of cooperation and communication between the CITY, the owner or developer, and the project's consultants in forecasting future traffic characteristics which realistically define traffic movement associated with

the proposed development. Specific requirements will vary depending on the site location.

8.10.02 Traffic Study Format

In order to provide consistency and to facilitate staff review of traffic studies, the following format shall be followed in the preparation of such studies by transportation consultants.

(A) Introduction:

The introduction portion of the report must contain the following:

1. A note stating the following: "We acknowledge that the City of Westminster's review of this study is only for general conformance with submittal requirements, current design criteria and standard engineering principles and practices. We are also aware of the provisions of section 11-6-5(B)3 of the Westminster Municipal Code."

2. A brief description of the size of the land parcel, general terrain features, the location within the jurisdiction and the region shall be included in this section. In addition, the roadways that afford access to the site and are included in the study area shall be identified. The exact limits of the study area should be based on engineering judgment and an understanding of existing traffic conditions surrounding the site. In all instances, however, the study area limits shall be mutually agreed upon by the developer, the developer's engineer, and the TRAFFIC ENGINEER. A vicinity map that shows the site and the study area boundaries in relation to the surrounding transportation system shall be included.

3. The existing and proposed uses of the site shall be identified in terms of the various zoning categories of the CITY. In addition, the specific use for which the request is being made shall be identified, if known, since a number of uses may be permitted under the existing ordinances. It shall be the intent of the traffic study to evaluate the worst case traffic impacts for the proposed development allowed by the zoning. If several different uses are permitted by the zoning, the highest trip generation shall be assumed for the study.

4. A complete description (including a map) of the existing land uses in the study area, as well as their current zoning and use, shall be included. In addition, all vacant land within the study area and its assumed future uses shall be identified. This latter item is especially important where large tracts of undeveloped land are in the vicinity of the site and within the prescribed study area. Generally, much of this information can be obtained from the CITY's Planning Division staff.

5. Within the study area, the applicant shall describe and provide volumes for existing roadways and intersections, including geometrics and traffic signal control, as well as improvements contemplated by all affected government agencies. This would include the nature of the improvement project, its extent, implementation schedule, and the agency or funding source responsible. A map shall be provided showing the location of such facilities.

(B) Trip Generation and Design Hour Volumes:

A summary table listing each type of land use, the size involved, the average trip generation rates used (total daily traffic and AM/PM peaks) and the resultant total trips generated shall be provided. Trip generation shall be calculated for the maximum uses allowed under the existing and proposed zoning based on the latest data contained within the Institute of Transportation Engineers (ITE) Trip Generation Manual, or other applicable sources. In the event that data is not available for the proposed land use, the CITY must approve estimated rates prior to acceptance. The calculation of design hour volumes used to determine study area impacts shall be based on:

1. Peak hour trip generation rates as published in the latest version of the ITE Trip Generation Manual or other applicable sources.

2. Traffic volume counts for similar existing uses if no other published rates are available.

3. Additional sources from other jurisdictions, if acceptable to the TRAFFIC ENGINEER.

Use of reduction factors to account for passby traffic may be considered upon approval of the TRAFFIC ENGINEER. Internal trip reductions and modal split assumptions will require analytical support to demonstrate how the figures were derived and will require approval by the TRAFFIC ENGINEER.

(C) Trip Distribution:

The estimates of percentage distribution of trips from the proposed development to destinations in the metro region shall be clearly stated in the report using the north, south, east, and west compass points. Market studies and information concerning origin of trip attractions to the proposed development may be used to support these assumptions where available. A map showing the percentage of site traffic on each street shall be provided as part of the traffic study graphic material.

(D) Trip Assignment:

The direction of approach of site-generated traffic via the area's street system shall be presented in this section. The technical analysis steps, basic methods, and assumptions used in this work shall be clearly stated and agreed to by the TRAFFIC ENGINEER. The assumed trip distribution and assignment shall represent the most logically traveled routes for drivers accessing the proposed development. These routes can be determined by observation of travel patterns to existing land uses in the study area.

(E) Existing and Project Traffic Volumes:

Graphics shall be provided which show the following traffic impacts for private access points, public intersections, and public streets.

1. AM peak-hour site traffic (in and out), including turning movements.

2. PM peak-hour site traffic (in and out), including turning movements.

3. AM peak-hour total traffic (in and out), including site-generated traffic. These volumes must include through and turning movement volumes for current conditions and separate set of numbers that also include twenty (20) year projections or build-out, whichever is specified by the TRAFFIC ENGINEER.

4. PM peak-hour total traffic (in and out), including site-generated traffic. These volumes shall include through and turning movement volumes for current conditions and a separate set of numbers that also include twenty (20) year projections or build-out, whichever is specified by the TRAFFIC ENGINEER.

5. Any other peak hour which may be critical to site traffic and the street system in the study area should be included in the graphics and show the same information as is provided for the AM/PM peak hours.

6. Actual counts of existing total daily traffic for the street system in the study area at the time the study is being prepared.

7. Projected total daily traffic for the street system in the study area based on traffic from the proposed development and counts of existing daily traffic obtained in Item 6 above. The component of the existing daily traffic attributable to the existing uses shall be identified and the increase in total daily traffic from the proposed uses.

8. Projected total daily traffic for the street system in the study area based on traffic from the proposed development, counts of existing daily traffic obtained in Item 6 above, traffic projections based on build-out of land use within the study area, or a twenty (20) year projection, whichever is specified by the TRAFFIC ENGINEER.

All raw traffic count data, including average daily volumes and peak-hour turning movements, and analysis worksheets shall be provided in the appendices of the report. Computer techniques and the associated printouts may be used as part of the report. Volume projections for background traffic growth will be provided by the developer's engineer and approved by the TRAFFIC ENGINEER. All total daily traffic counts shall be actual machine counts and not based on factored peak-hour sampling. Latest available machine counts from the CDOT, the CITY, and other agencies may be acceptable if not more than two (2) years old and approved by the TRAFFIC ENGINEER.

(F) Level of Service:

Level of Service "C" shall be the design objective for all movements, and under no circumstances will less than level of Service "D" be accepted for site and non-site traffic, including existing traffic at build-out of the study area. The design year will be approximately twenty (20) years following construction and include volumes generated by build-out of the study area or a twenty (20) year projection in background traffic, whichever is specified by the TRAFFIC ENGINEER. Level of Service shall be reported in the quantitative terms as expressed in the latest edition of the *Highway Capacity Manual*.

(G) Capacity Analysis:

A capacity analysis shall be conducted for all public street intersections impacted by the proposed development and for all private property access points to streets adjacent to the proposed development and within the limits of the previously defined study area. The AM, PM, and any other possible peak period shall be tested to determine which peak hours need to be analyzed. Capacity calculations should also include an analysis for the twenty (20) year projections or study area build-out conditions. The capacity analysis calculations should be based on the latest approved techniques as published in the latest edition of the Highway Capacity Manual. All capacity analysis worksheets shall be included in the appendices of the report.

(H) Traffic Signals:

The need for new traffic signals shall be based on warrants contained in the MUTCD and any additional warrants established by the National Committee on Uniform Traffic Control Devices. In determining the location of a new signal, traffic progression is important. Generally, a spacing of one-half (1/2) mile for all signalized intersections should be

maintained. This spacing is desirable to achieve good speed, capacity, and optimum signal progression. Pedestrian movements shall be considered in the evaluation and adequate pedestrian clearance provided in the signal cycle split assumptions.

To provide flexibility for existing conditions and ensure optimum two-way signal progression, an approved traffic engineering analysis shall be made to properly locate all proposed accesses that may require signalization. The section of roadway to be analyzed for signal progression will be determined by the CITY and will include all existing and possible future signalized intersections.

The progression pattern calculations shall use a cycle consistent with current signal-timing policies of the CITY. A desirable band width of fifty percent (50%) of the signal cycle shall be used where existing conditions allow. Where intersections have no signals presently but are expected to have signals, typically a sixty percent (60%) mainline, forty percent (40%) cross-street cycle split should be assumed. Cycle split assumptions shall relate to volume assumptions in the capacity analysis of individual intersections, and where computerized progression analysis techniques are used, they shall be the type which utilize turning-movement volume data and pedestrian clearance times in the development of time/space diagrams. The green time allocated to the cross street shall be considered no less than the time which is required for a pedestrian to clear the main street using the MUTCD standards. Those intersections which would reduce the optimum band width if a traffic signal were installed may be required by the CITY to remain unsignalized and have turning movements limited by access design or median islands.

(I) Traffic Crashes:

Traffic crash data for affected street corridors may be required for the study. The study period will normally be three (3) years. Such locations will be specified by the TRAFFIC ENGINEER. Where this is necessary, estimates of increased or decreased crash potential shall be evaluated for the development, particularly if the proposed development might impact existing traffic safety problems in the study area, and safety improvements recommended where necessary.

(J) Noise Attenuation:

If a residential development is planned adjacent to a freeway or arterial roadway, the Developer may be required to comply with all noise mitigation measures per current regulations.

(K) School Zones:

If the proposed development contains a school (K-12), the study shall include the location of all reduced school speed limit zones designed per

the CITY School Zone Policy. School zone flashers shall be installed with the school project on all collector and higher classification roadways.

(L) Recommendations:

In the event that analysis indicates unsatisfactory levels of service on study area roadways, a description of proposed improvements to remedy deficiencies shall be included. These proposals would include projects by the CITY or CDOT for which funds have been appropriated and obligated. The assumptions regarding all future roads and laneages in an analysis will require approval from the TRAFFIC ENGINEER. In general, the recommendation section should include:

1. Proposed Recommended Improvements. This section must describe the location, nature, and extent of proposed improvements to assure sufficient roadway capacity. A sketch of each improvement should be provided showing the length, width, and other pertinent geometric features of the proposed improvements.

2. Level of Service Capacity Analysis at Critical Points. Another iteration of the operational analysis shall be described which demonstrates the anticipated level of service as a result of making these improvements. This level of service must be "D" or better.

3. Traffic Volume Proportions. Percentages based on the traffic impact analysis may be required by the CITY to determine the proportion of traffic using various public improvements (both existing and proposed) from several developments within the study area.

(M) Conclusions:

This last section of the report must be a clear, concise description of the study findings explained in a manner that a citizen could understand as the language in this section will be inserted into the Planning Commission and City Council agenda memorandums. At minimum, the summary will include information pertaining to existing site generated traffic, impacts and mitigation measures, and when they will be implemented.

(N) Revisions to Traffic Study:

Revisions to the traffic study shall be provided as required by the TRAFFIC ENGINEER. The need to require revisions will be based on the completeness of the traffic study, the thoroughness of the impact evaluation, and the compatibility of the study with the proposed access and development plan.

8.10.03 Summary of Typical Study Contents

(A) Introduction:

1. Land Use, Site, and Study Area Boundaries (provide map)
2. Existing and Proposed Site Uses
3. Existing and Proposed Uses in Vicinity of Site (provide map)
4. Existing and Proposed Roadway and Intersections (provide map), including but not limited to:
   (a) Road geometry
   (b) Number of lanes
   (c) Auxiliary turning lanes, including storage length and tapers
   (d) Medians

(B) Trip Generation and Design Hour Volumes (provide table)

(C) Trip Distribution (provide figure)

(D) Trip Assignment (provide figure)

(E) Existing and Projected Traffic Volumes (provide figure for each item):

1. AM Peak Hour Site Traffic (including turning movements)
2. PM Peak Hour Site Traffic (including turning movements)
3. AM Peak Hour Total Traffic (including site-generated traffic and projected traffic)
4. PM Peak Hour Total Traffic (including site-generated traffic and projected traffic)
5. Any Other Peak Hour Necessary for Complete Analysis
6. Total Daily Existing Traffic for Street System in Study Area
7. Total Daily Existing Traffic for Street System in Study Area and New Site Traffic
8. Total Daily Existing Traffic for Street System in Study Area plus New Site Traffic and Projected Traffic from Build-Out of Study Area Land Uses

(F) Level of Service

(G) Capacity Analysis (provide analysis sheets in appendices)

(H) Traffic Signals (provide analysis sheets in appendices)

(I) Traffic Crashes (as required by the CITY) (provide collision diagrams and crash rates)

(J) Noise Attenuation

(K) Conclusions

(L) Recommendations:

1. Proposed Recommended Improvements (provide sketches of improvements)

2. Volume/Capacity Analysis at Critical Points (provide analysis sheets in appendices

3. Traffic Volume Proportions

NOTE: Information required on figures may be combined provided that the information is clearly legible.

8.11.00 ACCESS REQUIREMENTS AND CRITERIA

This section sets forth the minimum access requirements and criteria for access to roadways in the CITY. Access criteria are summarized below in Table 8.11.00. Refer to Sections 8.11.05 through 8.11.08 for requirements for each street classification.

TABLE 8.11.00
Access Management Criteria[1]

		Major Arterial		Minor Arterial		Major Collector	Minor Collector	Local Detached	Local Attached
		Without raised median	With raised median	Without raised median	With raised median				
Distance between intersections	Signalized	2640'		2640'		NA	NA	NA	NA
	Unsignalized	1320'[2]	660'[3]	1320'[2]	440'[3]	330'	330'	150'	150'
Distance between high volume driveways and intersections		1320'[2]	440'[3]	1320'[2]	330'[3]	200'	175'	150'	150'
Distance between double drives		440'		200'		75'	50'	12'	12'
Corner clearance between driveways/alleys & street intersections		440'		330'		150'	100'	40'	40'
Driveway approach street configuration		Radius curb return		Radius curb return		Curb cut[4]	Curb cut[4]	Curb cut	Curb cut

1. Values shown here are minimum distances. A variance from these values require approval from the CITY ENGINEER.
2. Minimum spacing for full movement and/or potentially signalized intersections.
3. Minimum spacing for partial movement intersections.
4. Radius curb returns are also allowed where traffic volumes meet the requirements for a high volume driveway.

8.11.01 Definition of Terms

For the purposes of this section the following definitions apply (see Figure 8.11.01 at the end of this section for an image of the application of the definitions):

(A) Width of Curb Opening (W) -- The width of curb opening measured at the curb line.

(B) Edge Clearance (E) -- The distance measured along curb line from the nearest edge of the curb opening to a point where the property line extended intersects the curb line.

(C) Corner Clearance (C) -- At an intersecting street, the distance measured along the curb line from the projection of the intersection street right-of-way line to the nearest edge of the curb opening.

(D) Distance Between Double Drives (D) -- The distance measured along the curb line between the inside edges of two adjacent curb openings.

(E) Setback (S) -- The lateral distance measured perpendicular to the street right-of-way line and extending from the right-of-way line to the closest point on a structure.

(F) Frontage -- The distance along the street right-of-way line of a single property or development within the property lines. Corner property at an intersection would have a separate frontage along each street.

(G) Throat Length (T) – The distance measured along the curb line from the property line to the first conflict point in the driveway.

(H) Residential -- Property used primarily for residential purposes such as single-family, two-family, and multi-family units.

-- Single-Family (SF) Residential: Single, detached family dwelling units, double bungalows, or duplexes.

-- Multi-Family (MF) Residential: Three or more attached dwelling units including townhouses, condominiums, and apartments.

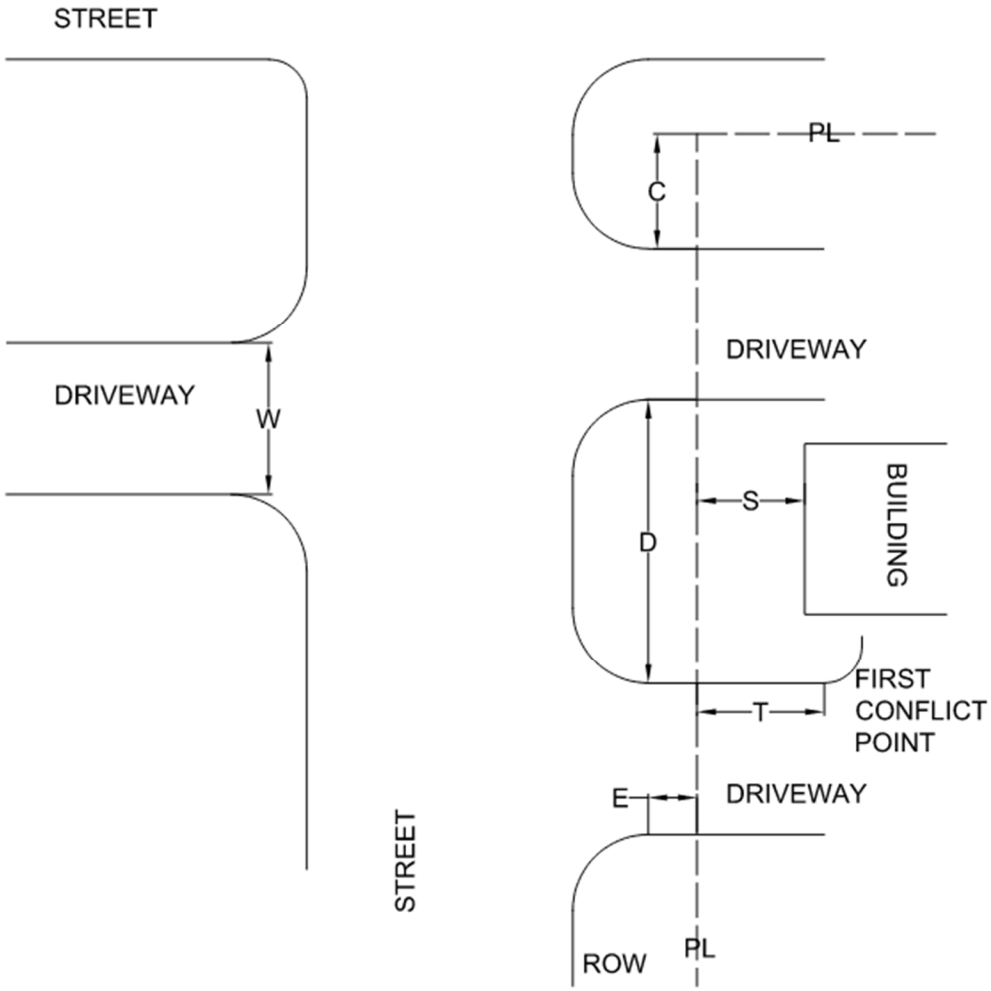
(I) Commercial -- Establishments where the buying and selling of commodities, entertainment, or services is carried on, excluding service stations. Included are such uses as office buildings, restaurants, hotels, motels, banks, grocery stores, theaters, parking lots, trailer courts, and public buildings.

(J) Service Station -- Any property where flammable liquids such as motor vehicle fuel are used, stored, and/or dispensed from fixed equipment into fuel tanks of motor vehicles.

(K) Industrial or Warehouse -- Any establishment that manufactures or stores an article or product.

(L) High Volume Driveway – A driveway that provides access onto an arterial roadway or a driveway with a volume of at least 350 vehicles per day that provides access to a collector roadway.

FIGURE 8.11.01
Access Requirement Definitions Image



8.11.02<u>General Requirements</u>

(A) Number of Openings:

1. <u>Single-Family Residential</u>. In general, each single-family residential property shall be limited to one (1) access point.

2. <u>Multi-Family Residential</u>. In general, access shall be determined by information provided by the owner/developer in the traffic impact study and by comments generated during the TRAFFIC ENGINEER's review and acceptance of that study.

3. <u>Commercial</u>. In general, commercial property having less than one hundred and fifty feet (150') of frontage and located mid-block shall be limited to one (1) access point to the street. An exception to this rule may be where a building is constructed in the middle of a lot and parking is provided for on each side of the building. A second access point may be allowed for commercial property having more

than one hundred fifty feet (150') of frontage. For commercial property located on a corner and there is sufficient frontage to provide for minimum and maximum requirements, one (1) access to each street may be permitted.

4. Service Stations. Where there is sufficient frontage to provide for minimum and maximum requirements, two (2) access points to a street may be permitted.

5. Industrial. Access shall be determined on a case-by-case basis. The City shall consider good traffic engineering practice and the information provided by the applicant in the traffic impact study accompanying the submittal.

(B) Amount of Curb Opening Permitted:

The total width of curb opening on a street for access to a commercial property or service station shall not exceed thirty-five feet (35'). This requirement does not apply to residential-type curb openings.

(C) Entrance Angle:

In general, the entrance angle for all driveway approaches shall be as near ninety degrees (90°) to the centerline of the street as possible. The minimum angle which will be permitted is ninety degrees (90°) plus or minus ten degrees (10°) for a minimum of 25 feet measured perpendicular to the street and measuring from the curb or edge of pavement toward the private property served.

(D) Minimum Space Between Openings:

The minimum spacing between curb openings shall be thirty-five feet (35') measured at the curb line. This spacing shall apply to double drives that serve a single property, as well as the distance between drives serving adjoining properties. A fifty-foot (50') spacing applies to commercial openings.

(E) Joint Entrances:

When a property does not have the necessary frontage to accommodate the required spacing from an intersection or from an existing driveway on an adjacent property, a recorded public common access easement with an adjacent property may be utilized to obtain the necessary spacing. Where site limitations preclude such common access easements, or where cooperation of adjacent property owners cannot be obtained, the CITY ENGINEER may issue a variance for a non-compliant driveway, which should be spaced as far from the intersection as practical, provided that the applicant can demonstrate that the proposed drive would not result in a traffic safety hazard. In cases where non-compliant driveways are

authorized, additional safety measures may be required (e.g., right-in, right-out only, channelization, additional signs, etc.).

8.11.03 General

New access to CITY streets and roadways is approved through one of the following mechanisms:

(A) For new developments, access is granted through City Council approval of the Preliminary Development Plan; or

(B) To obtain access to CITY streets from existing developed property, the mechanism is dependent upon zoning.

(C) For Planned Unit Developments, new or altered access shall be obtained through the CITY Preliminary or Official Development Plan amendment process. This involves applying through the Planning Division for an amendment to the appropriate development plan. The application should be accompanied by appropriate plans for the proposed access and technical justification, including justification for the extent of the improvements proposed at the access point.

(D) For property classified as a standard zoning district (other than Planned Unit Development), the application should be made to the Planning Division and accompanied by plans of the proposed access and technical justification for the access and associated public improvements.

The TRAFFIC ENGINEER may be available to provide advice on the extent of technical justification required for any access request. It is recommended that this advice be sought prior to submitting any application.

8.11.04 State Highways

(A) Access to state highways is governed by the State Highway Access Code.

(B) The CITY has delegated its authority to administer the State Highway Access Code to CDOT who is, therefore, responsible for the review of issuance of access permits to State Highways in the CITY.

8.11.05 Major Arterials

(A) A Right-of-Way Permit shall be obtained from the CITY's Engineering Division for any public or private access constructed on a major arterial.

(B) Private, direct access to major arterials shall be permitted only:

1. When the property in question has no other reasonable access to the general street system; or

2. When denial of direct access to the major arterial and alternative direct access to another roadway would cause unacceptable traffic operation and safety problems to the overall traffic flow of the general street system.

(C) When direct private access must be provided, the following shall be considered:

1. Such access shall continue only until such time that some other reasonable access to a lower function category street is available and permitted. The Right-of-Way Permit should specify the future reasonable access location(s), if known, and under what circumstances what changes will be required.

2. No more than one (1) access shall be provided to an individual parcel or to contiguous parcels under the same ownership unless it can be shown that allowing only one access conflicts with safety regulations (e.g., fire access) or if additional access would significantly benefit safety and operation of the highway and is necessary to the safe and efficient use of the property.

3. An access shall be limited to right turns only (through signs and a raised median or channelizing device) unless it has the potential for signalization, left turns would not create unreasonable congestion or safety problems and lower the level of service, or if alternatives to the left turns would not cause unacceptable traffic operation and safety problems to the general street system.

(D) Public direct access to a major arterial where left turns are to be permitted shall meet the signal-spacing criteria under Section 8.11.05(D) of this chapter. Those that do not meet these requirements shall be limited to right turns only, unless they meet the requirements mentioned in Section 8.11.05(B) above. No local streets shall be permitted to intersect major arterials.

(E) Spacing and Signalization:

1. In general terms, full access to major arterials shall be limited to one-half (1/2) mile intervals, plus or minus approximately two hundred feet (200'), in order to achieve good speed, capacity, and optional signal progression.

2. To provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization.

8.11.06 Minor Arterials

(A) A Right-of-Way Permit shall be obtained from the CITY's Engineering Division for any public or private access constructed to a minor arterial.

(B) Private direct access onto a minor arterial will be permitted if it does not have the potential for signalization; if it does have the potential for signalization; and it meets the signal-spacing requirements for intersecting public streets stated below and does not interfere with the location, planning, and operation of the general street system and access to nearby properties.

(C) Public direct access to a minor arterial where left turns are to be permitted shall meet the following signal-spacing criteria. Those that do not meet these requirements shall be limited to right turns only, unless they meet the requirements of Section 8.11.05(B) above. No local streets shall be permitted to intersect minor arterials.

(D) Spacing and Signalization:

1. In general terms, full access to minor arterials shall be limited to one-half (1/2) mile intervals, plus or minus approximately one hundred feet (100'), in order to achieve good speed, capacity, and optional signal progression.

2. To provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization.

8.11.07 Major and Minor Collectors

(A) Private access to collectors shall be governed by the curb opening and driveway criteria in Sections 8.11.09 and 8.11.10. Single-family residence access to collectors is not permitted.

8.11.08 Local Streets

(A) Private access to local streets shall be governed by the following curb opening and driveway criteria.

8.11.09 Basic Principles for Curb Openings and Driveways

(A) Certain control values for curb openings and driveways require minimum dimensions in some instances and maximum values for other dimensions. The design of curb openings and driveways within the range of these dimensions will provide for good service on the part of the motorist using

the driveway while at the same time minimizing the interference to the traffic using the street. By controlling the location and width of openings of driveways along the street, it will be possible to avoid or eliminate long, open stretches where motorists can indiscriminately drive onto the street. The width of opening established in these STANDARDS AND SPECIFICATIONS are based on studies which indicate that the various width openings will accommodate vehicles of maximum size authorized on CITY streets.

(B) The opening or driveway width should be adequate to handle properly the anticipated traffic volume and character of traffic, as well as being within the limits specified for the type of property development. The controls established for curb openings and driveways shall apply to existing streets as well as new streets that may be developed in the future.

(C) To the greatest extent possible, all openings for driveways shall be located at the point of optimum sight distance along the street. For openings and driveways to commercial establishments and service stations, there shall be sufficient space reasonably cleared of any obstructions such that drivers entering the property will have sufficient sight distance to enable them to make proper and safe movements. The profile of a driveway approach and the grading of the adjacent area shall be such that when a vehicle is located on the driveway outside the traveled portion of street the driver can see a sufficient distance in both directions to enable him to enter the street without creating a hazardous traffic situation.

(D) Any adjustments which must be made to utility poles, street light standards, fire hydrants, catch basins or intakes, traffic signs and signals, or other public improvements or installations which are necessary as the result of the curb openings or driveways shall be accomplished without any cost to the CITY.

(E) Any curb opening or driveway which has been abandoned shall be restored by the property owner except where such abandonment has been made at the request of or for the convenience of the CITY. Abandoned access occurs if the access has been in a state of non-use for more than one year. Re-commencement of access use after one year shall be considered a change in use and a new approval may be required by the CITY to meet existing access management requirements.

(F) If the use of an existing access to right-of-way changes, or there is a change in the use of the property, the change in access use must the approved by the CITY. Change in access or property use may include, but is not limited to, change in the amount or type of traffic (20 percent or more daily trips or more than 100 total daily trips), structural modification, remodeling, change in type of business, expansion in existing business, change in zoning, change in property division creating new parcels, etc.

(G) Driveway approaches, whereby the driveway is to serve as an entrance only or as an exit only, shall be appropriately signed by and at the expense

of the property owner. The property owner will be required to provide some means of ensuring that the motorists will use the driveway either as an entrance only or an exit only, but not both.

8.11.10 Control Dimensions

To accomplish the objectives of the basic principles stated earlier, certain control dimensions are necessary. There are many variables which affect these control dimensions. Some of the variables are as follows: type of street classification, type of private property development, volume and type of traffic, and width of right-of-way.

(A) Width of Curb Opening (W):

The total width of curb opening for properties on various function street classifications shall be in conformance with the detail drawings in Chapter 6 of these STANDARDS AND SPECIFICATIONS.

(B) Curb openings of thirty-five feet (35') or more shall be constructed as radius curb returns.

1. Residential. No edge clearance is required for residential access. However, the drive shall not extend beyond the property line extended.

2. Commercial.

Access onto an Arterial -- 75 Feet Minimum Edge Clearance
Access onto a Local -- 75 Feet Minimum Edge Clearance

NOTE: Joint access with adjoining property is encouraged. Joint access shall be the only justification for reducing the minimum edge clearance dimension.

3. Service Stations.

Access onto an Arterial -- 5 Feet Minimum Edge Clearance
Access onto a Local -- 5 Feet Minimum Edge Clearance

(C) Corner Clearance:

It is important to locate driveways away from major intersections. This constraint is as much for the ability to enter and leave the property as for the benefit of intersection safety and operations. Exiting a driveway during peak-hour conditions at traffic signals is difficult where the queue of standing or slow-moving vehicles never allows a sufficient gap for entry from the driveway. Driveways are not allowed within the functional area of an intersection, which includes deceleration lanes as specified in Section 6.22.00 of these STANDARDS AND SPECIFICATIONS.

(D) Sight Distance:

Sight distance for curb openings to private property shall be in accordance with Chapter 6 of these STANDARDS AND SPECIFICATIONS.

(E) Throat Length:

Driveway throat length is important for safe and efficient traffic operations on site and the adjacent street. The throat length needs to be of a sufficient length so that vehicles may enter, exit, and circulate on site without interference of traffic on the street.

1. For driveways serving between 100 and 400 vehicles in the peak hour (two-way traffic volumes) the driveways must provide at least 150 feet of throat length.
2. For driveways serving over 400 vehicles in the peak hour (two-way traffic volumes) and for all driveways controlled by a traffic signal, adequate throat length must be determined by the traffic impact study for the development.
3. A variance to the required throat length can be issued by the CITY ENGINEER based on the results of an engineering analysis, considering the ultimate public street section anticipated, ultimate buildout of the adjacent land, and function of the driveway.

8.12.00 PARKING

8.12.01 Regular Parking

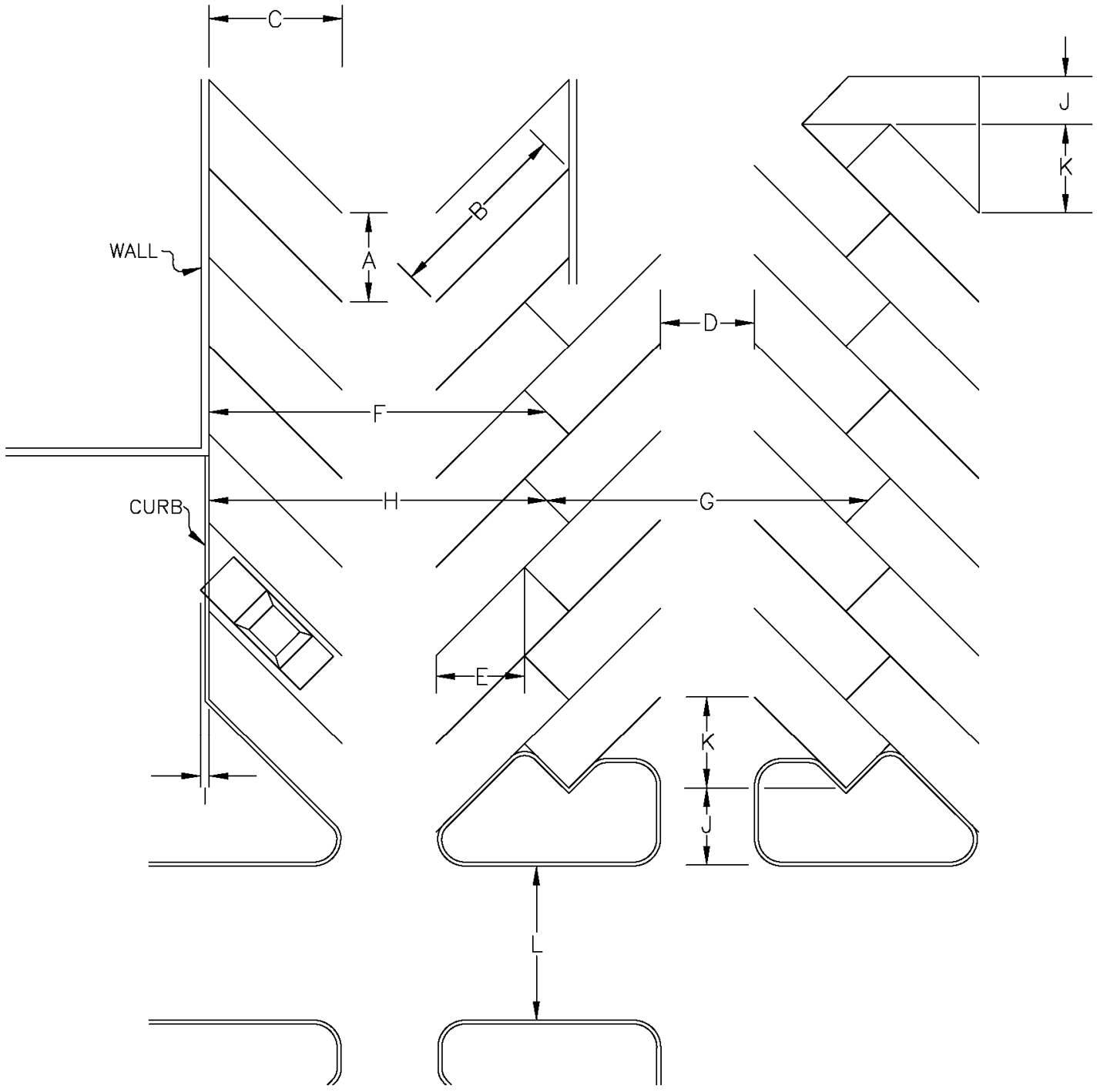
Conventional parking layout dimensions are provided in Table 8.12.01 and correspond to Figure 8.12.01. Other angled parking layouts meeting the approval of the TRAFFIC ENGINEER will be permitted where possible.

TABLE 8.12.01

Minimum Parking Layout Dimensions (In Feet) for 9-Foot Regular Parking Stalls at Various Angles

Dimension	On Diagram	Angle				
		0	45	60	75	90
Stall Width, Parallel to Aisle	A	9.0	12.5	10.5	9.5	9.0
Stall Length of Line	B	24.0	24.5	21.5	19.5	19.0
Stall Depth to Wall	C	9.0	17.0	18.5	19.0	19.0
Aisle Width Between Stall Lines	D	12.0	12.0	16.0	22.0	24.0
Stall Depth, Interlock	E	9.0	15.0	17.0	18.5	18.0
Module, Wall to Interlock	F	30.	44.0	51.5	59.5	60.0
Module, Interlocking	G	30.0	41.5	50.0	58.5	60.0
Module, Interlock to Curb Face	H	30.0	42.0	49.5	57.0	58.0
Bumper Overhang (Typ.)	I	0.0	1.5	2.0	2.0	2.0
Offset	J	-	6.5	2.5	0.5	0.0
Setback	K	24.0	11.0	8.5	5.0	0.0
Cross Aisle, One-Way	L	18.0	18.0	18.0	18.0	18.0
Cross Aisle, Two-Way	-	24.0	24.0	24.0	24.0	24.0

FIGURE 8.12.01
Parking Lot Layout



8.12.02 Compact Parking

Stall Layout. For ninety-degree (90°) compact parking, the minimum stall width shall be eight feet (8') and the minimum stall length at least sixteen feet (16'). Layout dimensions are provided in Table 8.12.02 and correspond to Figure 8.12.01. There shall be no bumper overhang for compact parking.

TABLE 8.12.02
Minimum Parking Layout Dimensions (In Feet) for 8-Foot Regular Parking Stalls at Various Angles

Dimension	On Diagram	Angle				
		0	45	60	75	90
Stall Width, Parallel to Aisle	A	8.0	11.5	9.0	8.5	8.0
Stall Length of Line	B	22.0	24.0	20.5	18.0	16.0
Stall Depth to Wall	C	8.0	17.0	18.0	17.5	16.0
Aisle Width Between Stall Lines	D	12.0	12.0	16.0	22.0	24.0
Stall Depth, Interlock	E	8.0	11.5	14.5	16.0	16.0
Module, Wall to Interlock	F	28.0	43.0	48.0	53.5	56.0
Module, Interlocking	G	28.0	35.5	44.5	54.0	56.0
Module, Interlock to Curb Face	H	28.0	43.0	48.0	53.5	56.0
Bumper Overhang (Typ.)	I	0.0	0.0	0.0	0.0	0.0
Offset	J	0.0	5.5	2.5	0.5	0.0
Setback	K	22.0	11.5	8.0	4.0	0.0
Cross Aisle, One-Way	L	18.0	18.0	18.0	18.0	18.0
Cross Aisle, Two-Way	-	24.0	24.0	24.0	24.0	24.0

8.12.03 Signing

Compact parking spaces shall be designated as being for the exclusive use of compact cars with a raised identification sign. The sign for compact car stalls must comply with the following:

(A) The legend shall read "Compact Cars Only" in green lettering on a white background.

(B) The minimum size of the sign shall be twelve inches by eighteen inches (12" x 18").

(C) Height of the sign must be a minimum of seven feet (7'). A height of four feet (4') will be permitted in non-pedestrian areas.

(D) Signs shall be reflectorized.

8.12.04 Maximum Allowable Grades Permitted in Parking Lots

Maximum grades permitted in parking lots must not exceed eight percent (8%).

8.12.05 Accessible Parking Posting

Each accessible parking stall should be between twelve feet (12') and fourteen feet (14') in width, must have a stall depth of at least nineteen feet (19'), and be located near buildings and accessible ramps. Dimensions of stalls shall meet the latest ADA guidelines referenced in Chapter 1. An accessible parking space will be required to be identified by an official "Disabled Reserved Parking" (MUTCD, R7-8) sign with the wheelchair logo.

In order for accessible parking spaces to function as intended, they will be required to be designed and signed in a uniform manner to allow for a clear understanding of the parking zone and to make enforcement possible. Signing of one, two, or three spaces for accessible parking spaces must be done by using one sign for each space placed at the center of each stall.

8.12.06 Parking Structures

The CITY will evaluate designs for such structures on an individual case basis.

8.13.00 BICYCLE LANES

8.13.01 General Requirements

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is located adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, street edge or parking lane.

Bike lane pavement markings and signage shall be in conformance with the MUTCD. Green pavement markings should be considered at conflict points.

8.13.02 Bike Lane Widths and Markings

The desired bike lane width is five feet (5') wide. Minimum dimensions vary with curbface conditions:

- Four foot (4') minimum width when adjacent to curb and gutter.
- Five foot (5') minimum for all other conditions.
- Additional bike lane or buffer width may be required at the CITY ENGINEER's discretion.

Bike lanes shall be delineated with a solid white line. Bike lane markings shall be placed at the beginning of every major driveway and/or intersection and at a minimum frequency of every three hundred feet (300').

8.13.03 Buffered Bike Lanes

Buffered bike lanes are conventional bicycle lanes paired with a designated horizontal buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.

Minimum buffer dimensions are:

- Adjacent to travel lane: Two feet (2')
- Adjacent to parking lane: Three feet (3')
- Additional bike lane or buffer width may be required at the CITY ENGINEER's discretion.

The buffer should be marked with two (2) solid white lines with interior diagonal cross hatching spaced at a distance equal to the roadway's speed limit. Cross hatching is required if the buffer width is greater than three feet (3'). For clarity at driveways or minor street crossings, consider a dotted line for the buffer boundary where cars are expected to cross.

8.13.04 Shared Bike Lanes

A shared bike lane is a shared environment with the vehicle travel lane and alerts motor vehicle drivers to the potential presence of bicyclists. The "Sharrow" bicycle symbol shall be used to provide positioning guidance for bicyclists outside of the door zone.

8.13.05 Bike Lanes and Right Turn Lanes

Where a separate right turn lane is provided on a facility with a bike lane, the right turn lane shall be designed with the bike separated by striping between the turn lane and through travel lanes. Refer to the standard drawings and the MUTCD for striping and signing treatments.

8.13.06 Bike Racks

Bike racks may be required to be installed adjacent to identified high user locations as directed by the CITY including, but not limited to, the following:

- Public transit facilities
- Schools
- Commercial destinations
- Transit Oriented Developments

Refer to the standard drawings for details of bike racks.

8.14.00 CROSSWALKS

8.14.01 General Requirements

Crosswalks are areas of roadway that are delineated to indicate where pedestrians are recommended to cross. Standard crosswalks shall be delineated with rectangular white crosswalk bars. In certain instances, crosswalks may have patterns or be constructed from materials that further increase their visibility.

8.14.02 School Crosswalks

Higher-visibility ladder-style crosswalk markings shall be placed in a roadway crosswalk contiguous to a school building or grounds.

8.14.03 Raised Crosswalks

A raised crosswalk is a marked pedestrian crosswalk at an intersection or a mid-block location constructed at a higher elevation than the adjacent roadway. A raised crosswalk is similar to a speed table, with the full width of the crosswalk contained within the flat portion of the table, typically ten feet (10') wide.

Raised crosswalk locations shall be approved by the CITY ENGINEER. Drainage must be accommodated by the developer with inlets or chase drains and approved by the CITY.

8.20.00 CONSTRUCTION STANDARDS

8.21.00 TRAFFIC SIGNALS

8.21.01 General Requirements

The work specified in this section describes the installation of necessary material and equipment to complete traffic signals and/or other electrical systems as specified on the drawings, in the special contract provisions, or herein.

8.21.02 Traffic Control and Street Closures

The CONTRACTOR will be required to maintain access to all private drives throughout the period of construction for this project. The CONTRACTOR shall be required to erect and maintain all barricades, traffic control signs, cones, and other traffic control items necessary to provide proper traffic control during construction. The CONTRACTOR shall submit the traffic control plan to the TRAFFIC ENGINEER for approval 72 hours prior to beginning construction. At the completion of the project the CONTRACTOR shall remove all barricades, traffic control signs, cones and other necessary construction traffic control items and return all areas or permanent traffic control devices damaged during construction to their original condition at no cost to the CITY. Traffic control signs

and devices shall be in accordance with Part VI of the MUTCD, latest edition, published by the Federal Highway Administration, and as directed by the TRAFFIC ENGINEER.

8.21.03 Intersection Power

The CONTRACTOR shall be responsible to contact Xcel Energy for requesting the power connection. Installation of an electric meter will require a CITY Building Permit. The CONTRACTOR is responsible for requesting a meter address from the TRAFFIC ENGINEER.

8.21.04 Equipment Salvage

Unless otherwise noted, all traffic signal equipment which is removed shall remain the property of the CITY. Such property is to be removed from the work site and returned by the CONTRACTOR to the CITY, as directed by the TRAFFIC ENGINEER. All delivery costs shall be the responsibility of the CONTRACTOR.

8.21.05 Existing Traffic Signals

When existing traffic signal installations are modified or completely rebuilt, the CONTRACTOR shall avoid disturbing existing traffic signal equipment until the new or modified traffic signal system has been installed and put into operation. If the existing traffic signal equipment must be removed to accommodate the new construction, the CONTRACTOR shall, with the TRAFFIC ENGINEER's approval and at no cost to the CITY, install temporary overhead traffic signal equipment. The CONTRACTOR shall at all times maintain a minimum of two (2) three-section (red, yellow, and green) traffic signal heads for each roadway approach during construction.

Existing traffic signals that will be modified with development may require full reconstruction based on the age and condition of the existing equipment. This determination will be made by the TRAFFIC ENGINEER using the CITY's signal health inventory.

8.21.06 Signal Heads

Signal heads installed on standards or poles at new signal locations which are not ready for actual electrical operation shall be bagged orange with an Out of Service reusable bag.

8.21.07 Field Location

All loops, poles, control cabinets, pull box locations, and pole foundations shall be field located by the TRAFFIC ENGINEER.

8.21.08 Utilities

All utilities shall be shown on the maps to the extent that they can, based upon utility records, surface field indications and proposed installations. During the progress of the work, all utility locations and elevations will necessarily require field verification in cooperation with the affected companies and public agencies. The CONTRACTOR shall be responsible for locating all valve boxes, manholes, etc., and ensuring that they are properly protected and/or adjusted.

8.22.00 REGULATIONS AND CODE

All electrical equipment and material shall conform to the standards of the National Electrical Manufacturers Association (NEMA). In addition to requirements of these specifications, the plans, the special contract provisions, all material, and work shall conform to the requirements of the National Electrical Code (hereinafter referred to as the "NEC"), the Rules for Overhead Electrical Line Construction of the Public Utilities Commission, the Standards of the American Society for Testing Materials (ASTM), and any local ordinance which may apply. Wherever reference is made in these specifications or in the special contract provisions to the code, rules, or the standards mentioned above, the reference shall be construed to mean the code, rule, or standard that is in effect at the date of bidding.

8.23.00 SUBMITTAL REQUIREMENTS

The submittal shall include all equipment and material as identified on the plans or in the specifications by the manufacturer's name which is necessary or customary in the trade to identify such equipment and material. The list shall be complete as to name of manufacturer, unit size, material composition and shall be supplemented by such other data as may be required by the TRAFFIC ENGINEER.

Inspection or sampling of any materials, other than those already approved, according to the material specifications must be made by the TRAFFIC ENGINEER prior to installation. If the CONTRACTOR proposes a substitution of equipment called for in the plans or specifications, he shall provide additional information in writing to prove the substitution item is of equal or superior quality. Any material and/or equipment installed by the CONTRACTOR that is not in conformance with these STANDARDS AND SPECIFICATIONS will be removed or changed at the CONTRACTOR's expense. Upon completion of the work, the CONTRACTOR shall submit an "as-built" plan showing, in detail, all construction changes including, but not limited to, wiring, cable, and location and depth of conduit.

8.24.00 BORING, EXCAVATING, AND BACKFILLING

Excavations for the installation of conduit, foundations, and other traffic signal items shall be performed in such a manner as to cause the least possible injury to the streets, sidewalks, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appliances and foundations. Excavating shall not be performed until immediately before installation of conduit and

other appliances. The material from the excavation shall be removed as the trenching progresses.

All conduit to be installed under existing roadways shall be bored. Trenches in proposed roadways shall be backfilled according to Chapter 9. After backfilling all trenches shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

Excavations in existing streets for conduit shall require CITY ENGINEER approval. All lane closures shall be approved by the TRAFFIC ENGINEER prior to closure. At the end of each day's work and any other time construction operations are suspended, all construction equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic. When excavations must remain open overnight, they shall be properly marked to warn motorists and/or pedestrians according to guidelines established in the MUTCD.

8.25.00 REMOVING AND REPLACING IMPROVEMENTS

If the CONTRACTOR removes material beyond the limits of disturbance in the plans, the material shall be repaired or replaced at the CONTRACTOR's expense. Whenever a part of a square or slab of existing concrete, sidewalk, or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed according to these STANDARDS AND SPECIFICATIONS.

The outline of all areas to be removed in concrete sidewalks and in pavements shall be a full depth cut to a neat vertical line, with no shatter outside the removal area, with an abrasive type saw prior to removing the sidewalk and pavement material.

8.26.00 UNDERGROUND FACILITIES

8.26.01 Foundations

(A) All foundations shall be CDOT Class BZ concrete conforming to the applicable requirements of these STANDARDS AND SPECIFICATIONS, except as herein provided.

(B) The bottom of concrete foundations shall rest on firm ground. Cast-in-place foundations shall be poured monolithically where practicable. The exposed portions shall be formed to present a neat appearance.

(C) Forms shall be true to line and grade. Tops of foundations, except as noted on plans, shall be finished to curb or sidewalk grade or as ordered by the engineer. Forms shall be rigid and securely braced in place and inspected prior to the pouring of concrete. Conduit ends and anchor bolts shall be placed in proper position and in a template until the concrete sets.

(D) Anchor bolts shall conform to the specifications and each individual bolt shall have two (2) flat washers and two (2) nuts. Shims or other similar devices for plumbing or raking will not be permitted.

(E) Both forms and ground which will be in contact with the concrete shall be moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

(F) All abandoned foundations shall be removed to a minimum 2' below finished grade and disposed of by the CONTRACTOR. The CITY ENGINEER may require a full depth removal on a case-by-case basis. All conduit runs associated with an abandoned foundation shall be extended or abandoned as called for on the plans. When a foundation is removed, the hole shall be backfilled in accordance with CDOT and these STANDARDS AND SPECIFICATIONS.

8.26.02 Conduit

(A) All conduit shall be PVC Schedule 80 or greater. All cables and conductors not shown on the plans as aerial cable shall be installed in conduit unless installed in poles, pedestals, or mast arms.

(B) All trenches excavated in new construction areas shall be backfilled with in accordance with these STANDARDS AND SPECIFICATIONS. Conduit to be installed under existing roadways shall be bored.

(C) Following conduit schedule is in effect unless otherwise specified in the plans:

Run Type	Quantity	Size (in.)	Use
Street Crossings	2	3	120 voltage
Street Crossings	2	2	Low voltage
Street Crossings	1	2	Xcel use
Signal Pole	2	3	Signal cables
Signal Pole	1	2	Xcel use
Controller Cabinet	2	3	120 voltage
Controller Cabinet	3	2	Low voltage
Fiber	1	2	Interconnect
Service Point	1	2	Xcel use

(D) The CONTRACTOR, at their sole expense, may use larger conduit if desired. Where larger conduit is used, it shall be for the entire length of the run from outlet. No reducing couplings will be permitted underground.

(E) The use of metal conduit shall be approved by the TRAFFIC ENGINEER. The end of all metal conduit, existing or new, shall be well reamed to remove burrs and rough edges. Field cuts of existing or new conduit shall be made square and true, and the ends shall butt together for the full

circumference thereof. Slip joints of running thread will not be permitted for coupling metal conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used. All couplings shall be screwed up until the ends of the metal conduits are brought together.

(F) Bored conduit bends shall have a radius of not less than six (6) times the inside diameter of the conduit. All conduit splicing must use E-Loc type couplers and must be approved by the TRAFFIC ENGINEER.

(G) Conduit shall be laid at a depth of not less than twenty-four inches (24") below the top of curb grade in sidewalk or grass areas and to a depth of not less than thirty inches (30") below the finished grade in all other areas. Conduit under railroad tracks shall meet applicable railroad requirements.

(H) Conduit shall always enter a foundation, pull box, or any other type structure from the direction of the run only.

(I) Conduits terminating in a pole shall extend approximately three inches (3") vertically above the foundation. All schedule 80 conduit must end with a pulling bell end bushing.

(J) All conduit runs shall have a continuous nylon line pulled into the conduit along with the specified electrical cables. The line shall be firmly secured at each end of the conduit run with a minimum slack of three feet (3'). The purpose of this line is to be able to pull future electrical cable through the existing conduit runs.

(K) Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel or blown out with compressed air.

(L) All empty conduit shall have a 14-guage stranded copper tracer wire installed.

8.26.03 <u>Pull Boxes</u>

(A) A pull box shall always be installed in combination with a traffic signal pole and at all other locations shown on the plans and at such additional points as ordered by the engineer.

(B) Special pull boxes which are required shall be fabricated and installed in general conformance with the size and details shown on standard drawings.

(C) Pull boxes installed in concrete or similar finished areas shall be designed for such installations and shall be stackable and manufactured of a pre-cast polymer concrete material or an approved equal, with minimum 22,000 lb load rating. Unless otherwise noted, pull box lids shall have the word “Traffic” cast into them. Pull boxes shall be installed so that the

covers are level with curb or sidewalk grade or level with the surrounding ground when no grade is established. Wherever possible, pull boxes should be installed outside of the accessible path. The bottoms of all pull boxes shall be bedded in minimum ¾" pea gravel or crushed rock to a minimum depth of two inches (2"). Conduit ends shall extend three inches (3") above the gravel or rock bed.

(D) When a new conduit run enters an existing pull box, the CONTRACTOR shall remove the pull box or tunnel under the side at no less than eighteen inches (18") below grade and enter from the direction of the run. No new conduit will be allowed to enter a new or existing pull box in any other manner than that shown on standard drawings.

(E) Loop detector pull boxes installed in the street shall be placed according to the plans or as directed by the engineer. The lids shall have the word "Traffic" cast into them.

8.26.04 Detector Loop Wire Installation

(A) Each individual detector loop is to be terminated within a water valve housing as specified on the construction drawing, and each loop shall consist of one continuous wire, without splicing, to this termination point. Any required series or parallel connections are to be at the termination point.

(B) All loops shall have a tag attached to the leading clockwise lead of the loop. This tag shall be marked to indicate the relative location of the loop. This marking shall correspond directly to the loop designations on the intersection drawing provided in the contract.

(C) Detector loop roadway slots shall be cut in asphalt that has a 6 inch (6") minimum depth and sealed one-fourth inch (1/4") below the surface level of the roadway with 3M or approved equal. This sealer is to be used whether or not the roadway is to be overlaid.

(D) The CONTRACTOR shall include cost for loop wire, saw cutting, sealant, splice, and test for a complete installation of the loop to the termination point for the pay item price.

8.26.05 Conductor and Cable

(A) Wiring shall conform to appropriate articles of the NEC. Wiring within cabinets, junction boxes, etc., shall be neatly arranged.

(B) If needed, wire pulling lubricant or other approved lubricant shall be used in placing conductors in conduit.

(C) A common neutral conductor, separate from the signal light circuit neutral, shall be used for all low-voltage circuits, including the detectors and pedestrian push-button circuits.

(D) Splicing of cable will not be permitted in conduit or pull boxes or outside of signal heads, standards or foundations.

(E) In no case shall any shellac compounds be used. Buchanan or approved equal type connectors shall be used on all splices made above ground level. Detector loop lead-in splices in underground systems shall be waterproofed with 3M splice kits or CITY approved equivalent. A minimum of twelve inches (12") of slack shall be left at each splice except within hand-holes where twenty-four inches (24") shall be left.

(F) When conductors and cables are pulled into the conduit, all ends of conductors and cables shall be taped to exclude moisture and shall be so kept until the splices are made or terminal appliances attached. Ends of spare conductors shall be taped and marked.

(G) Cable shall be stranded. For span wire type installations, cable shall be installed where specified on the plans and secured to messenger cable with cable rings in accordance with standard practices. Aerial cable shall be supported by strand vices of proper size and strength as well as insulators used where necessary.

(H) A small permanent tag on which the direction and phase is printed, in the order named, using the codes given in "**Cable Schedule**," shall be securely attached near the end of each conductor at each controller, standard, or pull box where conductors are separated. Where direction and phase are not clearly indicated by conductor insulation, additional tags shall be used.

TABLE 8-26-05
Cable Schedules

25 Conductor Wire		
Direction	**Conductor Color**	**Conductor #**
Main Street		
Main Street Red Ball	Red	3
Main Street Yellow Ball	Orange	5
Main Street Green Ball	Green	4
Main Street LT Red Arrow	Red/Green	20
Main Street LT Yellow Arrow	Black	1
Main Street FYA LT FYA Arrow	Orange/Green	21
Main Street LT Green Arrow	Blue	6
Main Street Walk	Green/White	14
Main Street Don't Walk	Red/White	13
Side Street		
Side Street Red Ball	Red/Black	8
Side Street Yellow Ball	Orange/Black	10
Side Street Green Ball	Green/Black	9
Side Street LT Red Arrow	Red (2)	19
Side Street LT Yellow Arrow	Orange/Red	18
Side Street FYA LT FYA Arrow	Black/Red	16
Side Street LT Green Arrow	Blue/Red	19
Side Street Walk	Blue/White	15
Side Street Don't Walk	Black/White	12
Right Turn		
Right Turn OL Yellow Arrow	Black (2)	22
Right Turn OL Green Arrow	Blue/Black	11
AC - Return/Neutral		
AC – Return	White	2
AC - Return for Peds	White (2)	23
Spares		
Spare	White/Black	7
Spare	White/Red	17
Spare	Green (2)	25

Phase/Tag	Tape Color
1. NBLT	Red/White
2. NB	Red
3. SBLT	Green/White
4. SB	Green
5. EBLT	Orange/White
6. EB	Orange
7. WBLT	Blue/White
8. WB	Blue
9. Pedestrian	Yellow

NOTE: This is a typical cable schedule and shall be used for the wiring of all signal installations. A new cable schedule will be noted on the plans at each intersection where different phasing and/or special equipment is required. It should be noted that a band of white is used to indicate a left turn and yellow for a pedestrian movement. This is in addition to directional tape for the phase. For cable size and number of conductors see traffic signal material specifications and/or standard drawings.

(I) Inboard and outboard heads, mounted on mast arms, are to be wired separately from head to base of pole.

8.26.06 Bonding and Grounding

(A) Metallic cable sheaths, metal poles, and foundations shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire, No. 8 AWG, for all systems. Beldon cable sheath for loop detectors to be grounded in control cabinet only. The other end of the sheath to be left ungrounded.

(B) Bonding of standards shall be by means of a bonding wire attached to a bolt or a three-sixteenths inch (3/16") or larger bolt installed in the lower portion of the shaft.

(C) At each pull box the ground electrode shall be a one-piece copper ground rod of five-eighths inch (5/8") diameter and eight feet (8') in length, driven into the ground so that the top is four inches (4") above the bottom of the pull box. The ground rod connector will be placed so that the bare copper wire, No. 8, can be pulled into a pole, foundation, or attached to the control cabinet ground buss.

8.26.07 Maintenance

The CONTRACTOR shall have full maintenance responsibility of the traffic signal from the date of the written notification by the TRAFFIC ENGINEER to the final inspection and date of written approval of the work performed. Continuous maintenance and emergency service shall be provided by the CONTRACTOR 24

hours each day during the time frame outlined above. The CONTRACTOR shall provide and maintain a 24-hour a day continuous one number telephone answering service. All malfunctions of a controller and its accessory equipment shall be considered an emergency unless otherwise identified by the City. Equipment malfunctions and/or damage, which in the opinion of Westminster's TRAFFIC ENGINEER or other authorized person, constitutes a serious hazard or inconvenience to the public shall be considered an emergency. Such malfunctions or damage may include, but not necessarily be limited to, situations where:

(A) all indications are out including LEDs, for any one traffic movement;

(B) signal heads give conflicting indications to any intersection approach;

(C) a signal has been knocked down;

(D) an overhead red indication is out.

CONTRACTOR shall undertake each such emergency repair no later than one hour after Westminster notifies CONTRACTOR of the emergency.

Should the CONTRACTOR fail to perform any maintenance responsibilities within the prescribed time periods, the TRAFFIC ENGINEER or other authorized person shall employ the services of the CITY's designated Traffic Signal Maintenance Contractor to perform said maintenance work. The CONTRACTOR shall reimburse the CITY for labor and equipment charges associated with the utilization of the CITY's designated Traffic Signal Maintenance Contractor plus a fifteen percent (15%) administration fee.

The electricity billing account for the traffic signal shall be transferred from the CONTRACTOR to the CITY after acceptance by the CITY.

8.26.08 Field Testing

Prior to completion of the work, the CONTRACTOR shall cause the following tests to be made on all traffic signals in the presence of the engineer or his designee.

(A) Each circuit shall be tested for continuity.

(B) Each circuit shall be tested for grounds.

(C) A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified or intended herein. The functional test for each traffic signal system shall consist of not less than thirty (30) days of continuous, satisfactory operation commencing with full operation of all electrical facilities. During the thirty-day period, the CONTRACTOR will maintain the system or systems. The cost of any maintenance necessary, except electrical energy and maintenance due

to damage by public traffic, shall be borne by the CONTRACTOR and will be considered as included in the price paid for the contract item involved, and no additional compensation will be allowed.

8.27.00 TRAFFIC SIGNING AND PAVEMENT MARKINGS

8.27.01 General

The installation of all traffic control devices shall conform to the MUTCD, latest edition, and the CDOT Standard Specifications for Road and Bridge Construction, latest edition.

8.27.02 Traffic Control Devices on Public Property

All permanently fixed traffic control devices will generally be installed by the DEVELOPER at no cost to the CITY. Traffic control devices shall be placed to conform to the drawing details. Unless otherwise noted, street name signs will be installed by the CITY at the DEVELOPER's expense.

8.27.03 Traffic Control Devices on Private Property

(A) Responsibility: All traffic control devices on private property (e.g., pavement markings, regulatory signs, stop signs for private drives entering public roads, fire lane signs, and accessible parking signs) shall be installed and maintained by the property owner.

(B) Placement: A signage and striping plan specifying the various types and combinations of traffic control devices shall be submitted to the TRAFFIC ENGINEER for approval.

(C) Damaged Private Signs: If the CITY is aware of a private sign that is damaged and requires corrective action, the CITY will make best efforts to contact the responsible party. If the CITY does not receive a response within twenty-four (24) hours the CITY will conduct the corrective action and bill the property owner for the work required.

8.27.04 Pavement Markings

All lane line pavement markings required to be installed as a result of new construction or development shall be epoxy. Alternative materials for lane lines may be required in certain cases by the TRAFFIC ENGINEER. Preformed tape may be required on concrete pavement for lane lines.

Pavement marking symbols such as turn arrows and bike lanes shall be preformed thermoplastic. The use of the "ONLY" word marking in turn lanes is discouraged and should be replaced with an additional arrow. Stop bars, yield lines, and crosswalk bars shall be thermoplastic. Alternative materials may be required in specific cases by the TRAFFIC ENGINEER.

Temporary pavement markings necessary to facilitate construction (i.e., detours) may be installed using paint.

The CONTRACTOR shall submit a plan for all pavement markings to the TRAFFIC ENGINEER for approval prior to the beginning of the work. The pavement marking plan shall meet the requirements for such work as outlined in the latest edition of the Manual on Uniform Traffic Control Devices. All pavement marking materials must be approved by the TRAFFIC ENGINEER.

8.28.00 TRAFFIC CONTROL IN CONSTRUCTION AREAS

8.28.01 General

The requirements of this chapter shall apply to any person, corporation, municipality, quasi-municipality agencies, mutual companies, electric, gas or communication utility (including telecommunications) who for any reason cuts, disturbs or otherwise defaces any City road for the purposes of installing or repairing or for any reason pertaining to the presence of an underground utility or structure.

For any construction done on, in or to an existing CITY roadway and/or right-of-way or for the construction of a new CITY roadway, appropriate traffic control during construction shall be provided. For any such construction, a TRAFFIC CONTROL PLAN shall be prepared by the CONTRACTOR and/or DEVELOPER and shall be approved by the TRAFFIC ENGINEER prior to issuance of a PERMIT.

Where a roadway does not currently exist, it is presumed that there is no motorist expectation of a travel route. Therefore, a TRAFFIC CONTROL PLAN for construction of a new roadway should strive to do two things: alert the motorist that this is a construction area and alert the motorist that the road is not open to traffic. TRAFFIC CONTROL PLANs shall also be prepared for construction occurring on existing CITY roadways where the motorist has an expectation of accessibility and shall be warned, advised, guided, or regulated through any construction activity.

8.28.02 Time of Submittal

A TRAFFIC CONTROL PLAN shall be submitted to the TRAFFIC ENGINEER at the earliest with the submittal of final construction plans and at the latest with the application for a right-of-way or public improvement construction permit(s). All final construction plans submitted to the CITY that entail constriction on an existing CITY roadway or construction of a new CITY roadway must either:

(A) Be accompanied by a TRAFFIC CONTROL PLAN.

(B) Include a note stating a TRAFFIC CONTROL PLAN shall be submitted to the CITY for approval before any permit for construction is issued. No PERMIT shall be issued without the approved TRAFFIC CONTROL PLAN.

8.28.03 Scope of Construction Traffic Control Plan

For construction of new roadways, traffic control during construction should strive to keep all modes of mobility from entering the facility. The primary means to accomplish this are by use of temporary barricades located in advance of the point where new construction joins old and appropriate signing. New roadways shall not be opened to general traffic and the construction traffic controls shall not be removed, without the approval of the CITY INSPECTOR and the TRAFFIC ENGINEER. One precondition of such an opening is that permanent signage and striping be in place.

8.28.04 Elements of Construction Traffic Control Plan

(A) All TRAFFIC CONTROL PLANs shall contain the following information:

1. Name of contracting firm and, if different, the name of the firm responsible for traffic control devices.

2. Name and phone number(s) of 24-hour contact person responsible for traffic control devices.

3. Description of location of activity (roadway names, north arrow, etc.)

(B) Projects identified as minor TRAFFIC CONTROL PLANs as determined by the TRAFFIC ENGINEER shall include, in addition to items listed in (A) above, either one of the following:

1. A detailed MHT of the roadways and the proposed traffic control devices; or

2. A copy of a typical drawing of traffic device layout from an accepted source approved by the TRAFFIC ENGINEER.

(C) Projects identified as major TRAFFIC CONTROL PLANs as determined by the TRAFFIC ENGINEER shall include, in addition to items in (A) above, the proposed traffic control devices specifically identified as to type and explicitly noted and dimensioned on construction plan drawings or other detailed drawings. Major projects shall require TRAFFIC CONTROL PLANs prepared by a certified Traffic Control Supervisor.

8.28.05 Basis for Construction Traffic Control Plan

The MUTCD, latest edition, shall be the basis upon which the TRAFFIC CONTROL PLAN is designed in concert with proper, prudent, and safe engineering practice. All necessary signing, striping, coning, barricading, flagging, etc. shall be shown on the plan.

8.28.06 Restriction, Regulations, and Opportunities

In concept, CITY streets shall not be closed overnight and work shall not force road or lane closures before 8:30 a.m. or after 3:30 p.m. If exceptions to this are required, this shall be noted on the TRAFFIC CONTROL PLAN and shall be approved by the TRAFFIC ENGINEER. Travel way width may be restricted. Minimum travel lane width in construction areas shall be ten feet (10'), but proper controls, including flagging, shall be indicated. Prohibition of on-street parking should be considered and noted where applicable.

All traffic control devices necessary to provide for public safety at the work site shall be furnished and maintained by the CONTRACTOR at the CONTRACTOR's expense.

8.28.07 Approval

The TRAFFIC ENGINEER shall approve all TRAFFIC CONTROL PLANs. All complete road closures and all partial road closures (removing one or more travel lanes) that are proposed for overnight shall be approved by the TRAFFIC ENGINEER. One (1) copy of the approved plan shall remain with the CITY INSPECTOR for their verification that the TRAFFIC CONTROL PLAN has been adhered to in the field. One (1) copy shall be placed in the engineering project file. The CONTRACTOR shall have one (1) approved copy of the TRAFFIC CONTROL PLAN on site at all times.

8.28.08 Modifications

Actual conditions in the field may necessitate modifications to the TRAFFIC CONTROL PLAN. Provided that the general intent of the original plan is satisfied, these modifications may occur without revision to the plan. The CITY INSPECTOR shall be notified of any substantial changes.

8.30.00 MATERIAL SPECIFICATIONS

8.31.00 SIGNAL HEADS

8.31.01 Traffic Signal Unit Specifications

(A) All signal units shall be of the individual section, adjustable type, black polycarbonate or approved equivalent. Unless otherwise noted on the plans, all signal and pedestrian displays shall be ITE approved LED and conform to the appropriate sections below. One southbound overhead red and green indication shall be SnowMelt LED type or approved equal and conform to sections B through C below.

(B) Visors shall be detachable, of the twelve-inch (12") tunnel type, open at the bottom; be black in color on the outside and flat black on the inside.

(C) Doors on the signal heads for the installation of LED replacement or other maintenance shall not require use of any tool whatsoever to be opened. Doors and LEDs shall be equipped with neoprene weatherproof gaskets to insure against infiltration of moisture, road film, and dust. Each three-color signal unit shall have the socket leads from all signal sections connected to a terminal board stamped with identifiable terminals. There shall be a terminal for color indication plus a common terminal where one lead from each socket shall terminate. The terminal board shall be mounted in the middle section and be properly insulated. All openings, top and bottom, shall be for one-half-inch (1/2") pipe or pipe mounting brackets. Gaskets shall be supplied for top and bottom openings.

(D) There shall be one signal face per lane. Side of pole signal faces shall be mounted on the far side right. Intersections with left turn phasing shall have far left side heads. Four section flashing yellow arrow indications shall be standard for all left turn phasing installed at intersections where protected/permissive left turn phasing is indicated.

8.31.02 <u>Pedestrian Signal Units</u>

Sixteen-inch (16"), one-way, ICC or equal, pedestrian signal head as specified on the plans. "Walk/Don't Walk" indications shall be symbolized with countdown indication. Pedestrian signal heads shall be facing back of pole on signal poles and pedestrian poles.

8.31.03 <u>Backplates</u>

(A) Where shown on the plans, black backplates shall be furnished and installed on signal faces. No background light shall show between the backplates and the signal face or between sections. All backplates are to be of aluminum construction and shall be the louvered type. Backplates shall provide a five-inch (5") border with a two-inch (2”) yellow retroreflective outline for all twelve-inch (12") signal heads.

(B) Traffic signal heads requiring backboards shall be drilled for three-sixteenths-inch diameter by one-half-inch (3/16" x 1/2") pan head bolt with nut and lock washer. If the manufacturer fails to supply as described, it will then be the CONTRACTOR's responsibility to do so. When installing backboards on the traffic signal head, the CONTRACTOR will furnish three-sixteenths-inch (3/16") fender washers between bolt head and backboard.

(C) The manufacturer will fabricate all backboards with a three-sixteenths-inch (3/16") washer on both sides of each rivet which is used to hold each section of backboard together.

8.32.00 ELECTRICAL CABLE

8.32.01 Signal Cable

14 AWG multi-conductor, stranded, copper wire manufactured to meet IMSA 25-1 specifications or approved equivalent. Each conductor in the cable will be individually insulated and rated at 600 volts. There shall be a minimum of four (4) and a maximum of nine (9) strands per conductor. There shall be a separate 25-conductor cable installed from the controller cabinet to the bottom handhold of each signal pole. From that point, a separate 5 or 7-conductor cable for each overhead signal and 7-conductor to outside signal head shall be spliced to the 25-conductor cable.

8.32.02 Interconnect Cable

Unless otherwise noted, all traffic signal interconnect communications shall be accomplished through a single-mode fiber optic cable system. Provisions for the fiber optic system shall be annotated on the plans or described by supplemental specifications. As a minimum the fiber optic cable shall be an outdoor rated single-mode cable, 96 fiber strands grouped into 8 buffer tubes of 12 each with wavelengths of 1300/1310 nm.

8.32.03 Loop Wire

Detect-A-Duct Cable consisting of single conductor No. 14, stranded THHN with an outer protective sleeve. No splices allowed in traffic valve box with loop wires pulled through to the closest pull box behind the curb for splice termination to loop lead-in cable.

8.32.04 Pedestrian Push-Button Cable

Two (2) conductor No. 14, seven (7) strands, tinned, soft-drawn copper wire, one-sixteenth-inch (1/16") neoprene insulation. Conductors to be twisted. Color coded one (1) white and one (1) black.

8.32.05 Loop Lead-In Cable

Detector loop lead-in cable shall be a four conductor 0.25 inch diameter, shielded and jacketed cable suitable for installation in a pavement sawslot, conduit or direct burial. Conductors shall be AWG No. 18 stranded copper with polypropylene insulation. The conductors shall be twisted at least six turns per foot. Color rotation shall be black, red, white, green. The interior of the cable shall be filled with an amorphous material which prevents water penetration. Aluminized polyester shielding shall be applied around the conductors to prevent electromagnetic interference. The cable jacket shall consist of black high density polyethylene. The jacket shall not be degraded by prolonged exposure to typical pavement runoff components. The cable shall be suitable for operation at temperatures of -60°C to +80°C. (Canoga 30003 43#18 AWG shielded loop detector lead-in cable or approved equal.)

8.32.06 Ground

Single conductor, AWG No. 8, soft-drawn bare copper wire.

8.32.07 Optical Detector Lead-In Cable

The lead-in cable for the Emergency Vehicle Optical Detectors shall be 3M Type 138 or approved equal.

8.33.00 VEHICLE DETECTORS

8.33.01 General

(A) Unless otherwise noted, all traffic signal vehicle detection systems shall be accomplished through a video camera system. All camera systems shall be 100 percent compatible and identical in both operations and programming with the CITY's existing Econolite Vision Camera system or approved newer Econolite model. The remaining portions of this section reference roadway imbedded inductive loop systems and are applicable when specified. This specification defines the minimum design operational and performance requirements for multiple channel, digital self-tuning inductive loop detectors, detector units shall be card rack mounted plug-in type and operate from an external 24 VDC power supply. Detector units shall be in full compliance with the environmental and size requirements of NEMA standard TS1-Section 15 and meet the design, operation, electrical and functional performance requirements of both TS1 and TS2 specifications.

(B) The front panel shall include an erasable, write-on channel identification area and clearly indicated switch operating position. I.D. area one centimeter square per channel minimum.

(C) All component part and test points shall be clearly identified by permanent marking of circuit referenced on the P. C. Board. Integrated circuit devices having 16 or more leads shall be socket-mounted to facilitate repair and maintenance of units. Detectors supplied to this specification shall be warranted by the supplier to be free of defects in materials and workmanship for a period of five years from date of shipment from manufacturer.

(D) Each detector unit shall include two or four complete detector channels. Each channel shall sequentially energize its loop inputs to eliminate crosstalk (mutual coupling) between large, very closely spaced adjacent loops connected to the same unit. The sequential time sharing and digital processing of loop inductance data shall be accomplished on a single LSI microcircuit per unit for maximum reliability. The method of measuring shall be crystal reference digital period counting, multi-channel scanning. Only one channel input per unit shall be active at any point in time.

1. Sequential scanning shall fully prevent crosstalk between channels of a detector connected to closely spaced or overlapped loops for directional detection.

2. Sequential scanning shall allow two detection channels to operate with full performance using a common home-run cable.

3. Sequential scanning shall allow two or more detection channels to be connected to a single detection amplifier with full operating performance, including separate mode and sensitivity selection capability on each channel.

(E) Each channel of the sensor unit shall automatically self-tune to any loop and lead-in inductance from 20 to 2500 microhenries within 2 seconds with full sensitivity after application or interruption of supply voltage. Units shall also track changes in loop/lead-in electrical characteristics, as might reasonably be expected to occur in undamaged loops, properly installed in sound pavements, without producing false indications or changes in sensitivity.

(F) Each detector unit shall be provided with a loop test switch position to verify loop system integrity and reduce maintenance costs. The "open loop test" position shall indicate a previous fault via the front panel indicator. The memory shall remain intact and can be queried repeatedly. Existing detections shall not be reset and the memory shall only be reset by power interruption as by removing and re-inserting the plug-in detector units.

(G) Each channel shall include a 16-position Push type wheel switch to allow selection of 8 pulse sensitivities, 7 presence levels and a "Reset" and an "Off" position. Each detector unit shall include 8 sensitivity selections in 2:1 steps that can be correlated to the relationship of the number of turns of wire in a loop versus the sensitivity required to detect a specified vehicle. The selections shall be designed to allow detection of licensable vehicles in loops of two or more turns electrically in series, parallel or series/parallel configuration in non-reinforced or reinforced pavements with lead-in/homerun combinations from 50-feet to 1000-feet. The number of turns in a loop, electrical configuration of multiple loops and pavement type will dictate the sensitivity required for proper, predictable detection.

(H) If specified, channel presence time shall be modified if delay or extension time is selected. The timing switch shall select delay or extension or "Off", if no timing is desired. Internal DIP switches shall provide for selection of "Delay" time of 0 to 31 seconds in 1.0 second increments and "Extension" time of 0 to 7-3/4 seconds in .25 second increments.

(I) Presence indicators shall be wide angle, high brightness type LEDs suitable for sunlight visibility. When timing is selected and a channel is active that channel's indicator shall flash at 4 Hz during Delay and at 16 Hz

during Extension to indicate timing is in progress. Further, the timing shall be aborted when the vehicle is no longer present and/or the channel control input shall become inactive. The Delay timer shall be reset when a vehicle leaves the loop prior to time out and shall abort when the control input becomes inactive. The Extension timer shall operate and reset when a vehicle leaves the loop and be aborted when the control input becomes inactive. Each timer (Delay and Extension) shall be provided with buffer circuitry to enable or disable the timer based on an external input (green gate) signal. Circuit shall be designed for AC or DC input control on AC powered units and for DC control on DC powered units.

(J) Each detector unit shall utilize a ΔL = (Delta-L) thresholding technique to provide a more constant, predictable vehicle detection sensitivity with series added inductance, (i.e., many loops connected in series and/or long lead-in/homeruns will generally require the same sensitivity setting as would be required for a single loop with short lead-in, to simplify setup).

(K) Each channel shall automatically recover from intermittent opens or multiple shorts to ground. Each channel shall tolerate and continue to operate with no change with a single point short to ground on the loop or lead-in system. Each channel shall provide a continuous, non-resettable (fail-safe) output and indication in response to an open loop/open lead-in system. The open loop indication and output shall not be resettable as long as the open exists, except that they shall be defeated when the channel "Off" position is selected.

(L) Extended features shall include: Two serial ports (front panel RS232 and Edge connector Xmit/Recve), TS1 and TS2 compatible from manual or software switch, microloop occupancy detection, Traffic counting capable to include long-loop presence count from 15 minute to infinite intervals all accessible from either serial interface, Dual Detect and Fault LED indicators per channel, External inputs to control Timing functions and enable Remote Reset, Extended diagnostics, programming and Live status available via serial interface utilizing windows compatible software.

8.34.00 EMERGENCY VEHICLE DETECTORS

Optical Communication Detectors for emergency vehicle pre-emption shall be the GTT Model 711, 712 or 722 Optical Detector or approved equal as specified in the construction plan notes. Placement of the Detectors shall be determined by the TRAFFIC ENGINEER. Optical phase selector modules for emergency vehicle pre-emption shall be GTT Model M762 or M764.

8.35.00 DETECTORS (PEDESTRIAN PUSH-BUTTON)

8.35.01 General

(A) Pedestrian push-buttons shall be of the direct push-button contact type. They shall operate on a voltage not to exceed 18 volts AC. They shall be of tamper-proof design and equipped with a push-button instruction sign as shown in the Standard Details.

(B) The assembly shall be weatherproof.

(C) The housing shall be shaped to fit the curvature of the pole to which it is attached to provide a rigid installation. Saddles shall be provided to make a neat fit when required. Pedestrian signs shall be installed as shown on the Standard Details.

(D) Pedestrian push buttons shall be accessible pedestrian signals meeting MUTCD and PROWAG requirements, shall be Polara APS three-wire equipment or approved equal, and shall be supplied with a dongle.

8.36.00 TRAFFIC SIGNAL POLES, PEDESTALS, AND MAST ARMS

8.36.01 Submittal Requirements

A Professional Engineer sealed and signed drawing or letter stating that the traffic signal structures meet the design criteria as stated in these STANDARDS AND SPECIFICATIONS will be required.

8.36.02 Traffic Signal Poles with Mast Arms

Traffic Signal poles are designed based on 4 pole sizes to accommodate the following grouping of mast arm lengths:

- 20'-30'
- 35'-45'
- 50'-60'
- 65'-70'

Traffic signal poles, lighting poles, pedestals, mast arms, and luminaire arms shall be of the general configuration shown in the CITY's Standard Details. Pole should be designed to accommodate the standard loads as shown on the standard plan drawing. All traffic signal poles and mast arms shall be designed to meet the most current edition of the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, using the following design criteria:

(A) Design shall use Typical Risk Category with an ADT > 10,000 (1700 year MRI) and 130 mph per Colorado special wind region.

1. Fatigue Category I (Traffic) or

    i. Design shall include Natural Wind Gust, Galloping and Truck-Induced Gust Fatigue Design Loads

2. Fatigue Category II (Traffic) must incorporate a CITY approved effective mitigation device.

    i. Design shall include Natural Wind Gust Fatigue Load. No Galloping and Truck-Induced Gust Fatigue Design Loads are required, when a CITY approved effective mitigation device is used.

    ii. Fatigue Category II traffic designs will only be accepted if the design includes a mitigation device that is deemed effective and has been given prior approval by the CITY. The mitigation device must be manufactured by the same manufacturer as the pole it is attached to and covered under the same warranty and liability terms. An acceptable mitigation device should be an active, non-aerodynamic vibration damper system to effectively mitigate the vertical movement under fatigue loads. Effectiveness must be proven through an analytical model and approved by the CITY ENGINEER prior to utilizing in a design. The pole manufacturer will be required to submit all the necessary documentation and testing of the device being used on their pole. Documentation and testing must prove the device is effective for a range of loading and pole frequencies by incorporating a dampening system for large displacements and a secondary dampening system for small displacements. The multi-design system must be self-adapting and must not require structure-specific tuning. The device must provide and documentation must show an 85 percent or greater excitation reduction. The mitigation device shall be tested to withstand over 15 million large amplitude cycles with no deterioration of the dampening performance.

    Currently pre-approved mitigation systems:
    - Valmont Mitigator TR1 Vibration Damper on tested Valmont structure

(B) Ice Loading is not required.

(C) Ring-Stiffened Box Connection for Traffic Mast Arms will be used per AASHTO Section/Figure 5.6.7-2.

(D) Do not design structure following AASHTO width ratio and clear distance for unreinforced and reinforced holes as shown in section 5.14.6 and 11.9.2.

(E) Welding shall meet requirements of AWS Latest Edition and AASHTO 2015 Section 5.14.

(F) All poles shall be wrapped to provide maximum protection from damage prior to shipping.

8.36.03 Finishes

All items shall be hot-dipped galvanized to ASTM A123 for fabricated products and ASTM A153 for hardware items. All processing will be result in a debris free zinc coating. Galvanizing shall be abrasive blasted to a uniform dull appearance.

All items before being assembled into a completed product shall be cleaned in a manner that will remove all impurities and foreign matter. After welding, all flux shall be removed. The final assembly will be dried to ensure no moisture is trapped in the product.

8.36.04 Final Steps

All poles shall be wrapped to provide maximum protection from damage prior to shipping.

Traffic signal poles and mast arms shall not be ordered until the exact location of the pole foundations are verified and there are no underground conflicts. Potholing or foundation excavation to determine potential conflicts shall not be paid for separately but shall be included in the unit bid costs.

8.37.00 CONTROLLER CABINET

8.37.01 General

This specification sets forth the minimum requirements for a TS2 Type 1 Traffic Control Plug-N-Go Cabinet Assembly. The cabinet assembly shall meet, as a minimum, all applicable sections of the NEMA TS2 Standard. The manufacturer shall be ISO 9001-2008 Registered and have been certified in the IPC "Class II" Electronics standard and training for all manufacturing staff to ensure manufacturing quality, documentation, and proper ongoing/continuing employee training for manufacturing processes by IPC Certified Trainers. The cabinet and controller supplied under this specification shall be by the same manufacturer to ensure matched component system testing. Where differences occur, this specification shall govern.

8.37.02 Cabinet Assembly Profile Detail

Each cabinet assembly provided to the CITY shall include the following as per outlined in the specification:

1 – P65 natural aluminum cabinet housing; painted white inside only
2 – Corbin #9 deadbolt locks
1 – Dual fan panel assembly
3 – LED light strips, 2 in top on fan panel and 1 under bottom shelf
2 – Full width cabinet shelves

2 – Battery shelves and covers mounted on the lower left side of cabinet
1 – Power auxiliary panel w/SHA-1210 surrestor, line filter, SSR, 1-40A CB, 2-15A CB, GFCI, extra neutral and GND bus
1 – 16 position vertical PNG main panel assembly
1 – Power buss assembly w/ 6 PNG power connectors
1 – 7-position SDLC hub assembly w/ 6 SDLC cables, screw down cables on hub end
1 – Aluminum washable cabinet air filter
1 – 8-channel detector rack and interface panel w/EVP interface cable
1 – Police/auxiliary switch assembly w/auto manual and police cord
1 – Generator transfer switch and confirmation light
1 – 6-position power strip wired to 4 position tb on left side, filtered power.
1 – 13" wide under shelf document drawer and laptop shelf
1 – 8 position load resistor panel assy
10 – Red jumpers for unused phases
1 – CCA2 controller power cable
1 – Flasher
6 – Flash transfer relays
16 – Load switches
1 – Model MMU2-16LEIP Malfunction Management Unit (MMU)
1 – Model EDI PS200 cabinet power supply
3 – Bus Interface Units (BIU)
1 – Hygrotherm humidity sensor and heater

8.37.03 <u>Cabinet Design and Construction</u>

(A) The cabinet shall be constructed from type 5052-H32 aluminum with a minimum thickness of 0.125 inches.

(B) The cabinet shall be designed and manufactured with materials that shall allow rigid mounting, whether intended for pole, base, or pedestal mounting. The cabinet shall not flex on its mount.

(C) A rain channel shall be incorporated into the design of the main door opening to prevent liquids from entering the enclosure. The cabinet door opening shall be a minimum of 80 percent of the front surface of the cabinet. A stiffener plate shall be welded across the inside of the main door to prevent flexing.

(D) The top of the cabinet shall incorporate a minimum of 1-inch slope toward the rear to prevent rain accumulation.

(E) Unless otherwise specified, the cabinet shall be supplied with a natural aluminum finish. Sufficient care shall be taken in handling to ensure that scratches are minimized. All surfaces shall be free from weld flash. Welds shall be smooth, neatly formed, free from cracks, blowholes, and other irregularities. All sharp edges shall be ground smooth.

(F) Where painted cabinets are specified, the exterior shall be degreased and primed with a spray applied iron phosphate coat – equivalent to a

four-stage iron phosphate coat, prior to painting. The final coat shall consist of a powder-coat paint (TGIC or equivalent) applied with a minimum thickness of 2 mils. The cabinet shall be painted inside only – White.

(G) All seams shall be continuous welded.

(H) The lower section of the cabinet shall be equipped with a louvered air entrance. The air inlet shall be large enough to allow sufficient air flow per the rated fan capacity. Louvers shall satisfy the NEMA rod entry test for 3R ventilated enclosures. A non-corrosive, removable aluminum air filter shall be secured to the air entrance. The filter shall fit snugly against the cabinet door wall.

(I) The roof of the cabinet shall incorporate an exhaust plenum with a vent screen. Perforations in the vent screen shall not exceed 0.125 inches in diameter.

(J) The main door and the police door-in-door shall close against a weather-proof, dust-proof, closed-cell neoprene gasket seal. The gasket material for the main door shall be a minimum of 0.250 inches thick by 0.500 inches wide. The gaskets shall be permanently bonded to the cabinet.

(K) The handle on the main door of the cabinet shall be manufactured from cast aluminum or stainless steel. The handle shall include a hasp for the attachment of an optional padlock. The cabinet door handle shall rotate counter-clockwise to open. The handle shall be positioned so that the handle shall not cause any interference with the key when opening the cabinet door.

(L) The main door hinge shall be a one-piece, continuous piano hinge with a stainless steel pin running the entire length of the door. The hinge shall be attached in such a manner that no rivets or bolts are exposed.

(M) The main door shall include a mechanism capable of holding the door open at approximately 90, 145, and 165 degrees under windy conditions. The cabinet shall be provided with one (1) door (front door).

(N) The cabinet door shall be equipped with a Corbin tumbler lock #9, with a minimum of two keys provided.

(O) The police door-in-door shall be provided with a treasury type lock, Corbin No. R357SGS or exact equivalent, with a minimum of one key provided.

(P) The main cabinet front door shall incorporate a shroud to cover the filtered louvered openings as appropriate for the design. The assembly is secured on the interior of the door over the filtered louvers. The shroud is louvered downward and matches the door louvers.

(Q) A minimum of one set of vertical "C" channels shall be mounted on each interior wall of the cabinet for the purpose of mounting the cabinet components. The channels shall accommodate spring-mounted nuts or studs. All mounting rails shall extend to within three (3) inches of the top and bottom of the cabinet. Rear-wall rail spacing shall be 18.50 inches center-to-center.

(R) For size 6 or larger cabinets, each sidewall shall have two (2) sets of equipment mounting rails. Each rail set shall be spaced 7.88 inches center-to-center. All channel nuts used to install equipment on the rails shall be the spring loaded type.

(S) All cabinets shall be supplied with three (3) removable shelves manufactured from 5052-H32 aluminum. The shelf shall be a minimum of 10 inches deep.

(T) The shelf shall have horizontal slots at the rear and vertical slots at the front of the turned down side flange. The shelf shall be installed by first inserting the rear edge of the shelf on the cabinet rear sidewall mounting studs, then lowering the shelf on the front sidewall mounting studs. The shelf shall be held in place by a nylon tie-wrap inserted through the holes on the front edge of the shelf and around the front sidewall mounting studs.

(U) The front edge of the shelf shall have holes punched every 6 inches to accommodate tie-wrapping of cables/harnesses.

(V) All base mounted cabinets require anchor bolts to properly secure the cabinet to its base. The cabinet flange for securing the anchor bolts shall not protrude outward from the bottom of the cabinet. Four (4) anchor bolts shall be required for proper installation.

(W) The cabinet shall be of sufficient size to accommodate all equipment. The minimal cabinet size is 65" H x 44" W x 26" D.

(X) All enclosures shall be constructed, approved and marked in accordance with the requirements for Type 1 Industrial Control Panel Enclosures contained in UL 508A, the Standard for Industrial Control Panels. The enclosure shall meet NEMA 3R rating requirements and be marked with a UL approval sticker.

8.37.04 Terminals and Facilities

(A) The terminals & facilities shall be supplied as a minimum in the following NEMA configuration: NEMA Configuration #4 – Sixteen (16) load switch sockets; six (6) flash transfer relay sockets; one (1) flasher socket; two (2) BIU sockets; one (1) 16-channel detector rack with one (1) BIU; one (1) Type-16 MMU.

(B) All terminals & facilities configurations shall be provided with BIU wiring assignments consistent with the current NEMA TS2 Standard.

(C) All terminals & facilities configurations shall be provided with sufficient RS-485 Port 1 communication cables to allow for the intended operation of that cabinet. Each communication cable connector shall be a 15-pin meal shell D subminiature type. The cable shall be a shielded cable suitable for RS-485 communications.

(D) The grounding system in the cabinet shall be divided into three (3) separate circuits: AC Neutral; Earth Ground; Logic Ground. These ground circuits shall be connected together at a single point as outlined in the current NEMA TS2 Standard.

8.37.05 <u>Main Panel Design and Construction</u>

(A) The main panel shall be constructed from 5052-H32 brushed aluminum of 0.125 inches minimum thickness and installed so as to minimize flexing when plug-in components are installed.

(B) The 16-position main panels are provided with a mounting mechanism which allows easy access to all wiring on the rear of the panel. Lowering of the main panel shall be accomplished without the use of hand tools. Complete removal shall be accomplished by the use of simple hand tools.

(C) All load switch and flash transfer relay sockets reference designators shall be silkscreen labeled on the front and rear of the main panel to match drawing designations. Socket pins shall be marked for reference on the rear of the panel.

(D) Main panel load switch sockets shall be positioned either vertically/stacked or in a horizontal row.

(E) All load switches shall be supported by a bracket, extending at least half the length of the load switch.

(F) The sixteen (16) load switch position main panels shall have all field wires contained on two (2) rows of horizontally mounted terminal blocks. The upper row shall be wired for the pedestrian and overlap field terminations.

(G) The field output circuits shall be terminated on a non-fused barrier type terminal block with a minimum rating of 10 amps.

(H) The field input/output (I/O) terminals shall be identified by permanent alphanumeric labels. All labels shall use standard nomenclature per the NEMA TS2 Standard.

(I) It shall be possible to flash either the yellow or red indication on any vehicle movement and to change from one color indication to the other by use of a screwdriver.

(J) Field terminal blocks shall be wired to use four (4) positions per vehicle or overlap phase (green; yellow; and red flash). It shall not be necessary to de-bus field terminal blocks for flash programming.

(K) The main panel shall contain at least one (1) flasher socket (silkscreen labeled) capable of operating a 15-amp, 2-pole, NEMA solid state flasher. The flasher shall be supported by a bracket, extending at least half its length.

(L) One (1) RC network shall be wired in parallel with each group of three flash transfer relays and any other relay coils.

(M) All logic-level, NEMA controller and Malfunction Management Unit input and output terminations on the main panel shall be permanently labeled. Cabinet prints shall identify the function of each terminal position.

(N) At a minimum, three (3) 20-position terminal blocks shall be provided at the top of the main panel to provide access to the controller unit's programmable and non-programmable I/O. Terminal blocks for DC signal interfacing shall have a number 6-32 x 7/32 inch screw as a minimum.

(O) All main panel wiring shall conform to the following wire size and color:

Green/Walk load switch output	Brown wire	14 gauge
Yellow load switch output	Yellow wire	14 gauge
Red/Don't Walk load switch output	Red wire	14 gauge
MMU (other than AC power)	Violet wire	22 gauge
Controller I/O	Blue wire	22 gauge
AC Line (power panel to black wire main panel)		8/10 gauge
AC Line (main panel)	Black wire	10 gauge
AC Neutral (power panel to white wire main panel)		8/10 gauge
AC Neutral (main panel)	White wire	10 gauge
Earth Ground (power panel)	Green wire	8 gauge
Logic Ground	Gray wire	22 gauge
Flash Programming	Orange wire	Various gauge sizes
Flasher Terminal	Black wire, red or yellow field terminal	14 gauge

(P) All wiring, 14 AWG and smaller, shall conform to MIL-W-16878/1, type B/N, 600V, 19-strand tinned copper. The wire shall have a minimum of 0.010 inches thick PVC insulation with clear nylon jacket and rated to 105 degrees Celsius. All 12 AWG and larger wire shall have UL listed

THHN/THWN 90 degrees Celsius, 600V, 0.020 inches thick PVC insulation and a clear nylon jacket.

(Q) Connecting cables shall be sleeved in a braided nylon mesh or poly-jacketed. The use of exposed tie-wraps or interwoven cables is not acceptable.

(R) All main panels shall be pre-wired for a Type-16 Malfunction Management Unit.

(S) All wiring shall be neat in appearance. All cabinet wiring shall be continuous from its point of origin to its termination point. Butt type connections/splices are not acceptable.

(T) All connecting cables and wire runs shall be secured by mechanical clamps. Stick-on type clamps are not acceptable.

(U) The main panel shall incorporate a relay, designated as K1, to remove +24 VDC from the common side of the load switches when the intersection is placed into mechanical flash. The relay shall have a momentary pushbutton to apply power to the load switch inputs for ease of troubleshooting.

(V) All pedestrian pushbutton inputs from the field to the controller shall be opto-isolated through the BIU and operate at 12 VAC.

(W) All wire (size 16 AWG or smaller) at solder joints shall be hooked or looped around the eyelet or terminal block post prior to soldering to ensure circuit integrity. Lap joint soldering is not acceptable.

(X) The main panel connections for power and all cabinet switch interfacing shall be via a 37-pin plastic shell MS connector with an incorporated twist lock as part of the Plug N Go cabinet system wiring.

8.37.06 Power Panel Design and Construction

(A) The power panel shall interface with the main panel and be located on the lower right portion of the cabinet. The power panel shall be wired to provide the necessary filtered power to the load switches, flasher(s), and power bus assembly. The technicians shall be protected from the power panel components with a removable Plexiglas front cover. The design shall allow a technician to access the main and auxiliary breakers without removing the protective front cover.

(B) The power panel portion of the main panel shall include the following components:

- One (1) 40-amp main circuit breaker. This breaker shall supply power to the controller, MMU, signals, cabinet power supply, and auxiliary panels. Breakers shall be at a minimum, a thermal magnetic type, UL

listed for HACR service, with a minimum of 10,000 amp interrupting capacity.

- One (1) 15-amp auxiliary breaker shall supply power to the fan, light, and GFI utility outlet.
- One (1) 15-amp circuit breaker shall supply filtered power to the power strip located elsewhere in the cabinet assembly. The circuit breaker shall be wired to the 4-position terminal block, located on the upper left side of the cabinet.
- An EDCO/HESCO model SHA-1210 or exact approved equivalent surge arrester.
- A 50-amp, 125 VAC radio interference line filter.
- A normally-open, 75-amp, solid state signal bus relay. The SSR shall be a Crydom Model# HA4875H or approved equivalent.
- A minimum of one (1) 8-position neutral bus bar capable of connecting three (3) #12 wires per position.
- A minimum of one (1) 6-position ground bus bar capable of connecting three (3) #12 wires per position.
- A minimum of one (1) NEMA type 5-15R GFI utility outlet.

8.37.07 <u>Power Bus Assembly – SDLC Hub Assembly</u>

(A) The power bus assembly shall be manufactured from 0.090", 5052-H32 aluminum. It shall provide filtered power for the controller, MMU, cabinet power supply, and all auxiliary equipment.

(B) The power bus assembly shall house the following components:

- A minimum of three (3) and a maximum of six (6) power connectors.
- Two (2) terminal strips to hardwire the power connections.

(C) All cabinet equipment requiring filtered power to operate shall be connected to the power bus assembly by a fourteen (14) pin plastic MS circular connector with a twist lock connection or hardwired directly to the supplied terminal blocks.

(D) SDLC connections shall be made via an eight (8) position SDLC Hub Assembly. The SDLC Hub assembly shall have provisions for the SDLC cable connectors to be tightened down the hub assembly by two screws. Six (6) SDLC cables shall be supplied with each cabinet.

8.37.08 <u>Auxiliary Cabinet Equipment</u>

(A) The cabinet shall be provided with two (2) thermostatically controlled (adjustable between 55-160 degrees Fahrenheit) ventilation fans in the top of the cabinet plenum. The fan plate shall be removable with the use of simple hand tools for serviceability. A minimum of two (2) exhaust fans shall be provided. The fans shall be a ball-bearing type fan and shall be capable of drawing a minimum of 100 cubic feet of air per minute each. The Fan/Thermostat assembly shall be connected to the power panel by means of a 4-position plug-in cable.

(B) An LED cabinet lighting system shall be used to illuminate the internal structure of the cabinet assembly. Two (2) LED cabinet lighting strips shall be mounted on the fan panel assembly in the top of the cabinet. The fan panel shall also incorporate the LED light power supply. The LED light strips shall be Califla Model P3100-C-S. The lamp shall be wired to a door activated switch mounted near the top of the door. A third LED light strip shall be mounted under the bottom shelf to illuminate the lower portion of the cabinet, specifically the field terminals.

(C) A document drawer shall be mounted to the underside of the bottom shelf to store the cabinet documents. The document drawer shall be a minimum of 13" wide.

(D) A minimum of two (2) sets of complete and accurate cabinet drawings shall be supplied with each cabinet.

8.37.09 <u>Vehicle Detection</u>

(A) One (1) loop detector rack shall be provided in each cabinet. The Detector rack shall be available in the following NEMA configuration: NEMA Configuration #2 – Shall support up to eight (8) channels of loop detection (either four (4) 2-channel detectors or two (2) 4-channel detectors), two (2) preemption devices, and one (1) BIU. This configuration shall be included as a standard on the 12- or 16-position main panel assembly.

(B) Detector rack BIU mounting shall be an integral part of the detector rack.

(C) All BIU rack connectors shall have jumper address pins corresponding to the requirements of the NEMA TS2 Standard. The jumpers may be moved to change the address of any individual rack. The address pins shall control the BIU mode of operation. BIUs shall be capable of being interchanged with no additional programming.

(D) Each cabinet shall contain detector interface panels for the purpose of connecting field loops and loop detector racks. The panels shall be manufactured from FR4 G10 fiberglass, 0.062 inches thick, with a minimum of 2 oz. of copper for all traces.

(E) One (1) 16-position interface panel shall be provided for a 16-channel rack cabinet. The interface panel shall be secured to a mounting plate and attached to the left wall of the cabinet.

(F) Each interface panel shall allow for the connection of eight (8) independent field loops. A ground bus terminal shall be provided between each loop pair terminal to provide a termination for the loop lead-in cable ground wire.

(G) Each interface panel shall provide a 10-position terminal block to terminate the field wires for up to two (2) 2-channel preemption devices.

(H) Lightning protection device mounting holes shall be provided to accommodate an EDCO SRA-16C or EDCO SRA-6 or EDCO LCA-6, or a varistor lightning protection device. Lightning protection devices shall not be provided unless specified.

(I) A cable consisting of 20 AWG twisted pair wires shall be provided to enable connection to and from the panel to a detector rack. The twisted pair wires shall be color-coded red and white wire.

(J) All termination points shall be identified by a unique number and silkscreened on the panel.

(K) Each detector rack shall accommodate rack-mountable emergency vehicle preemption (EVP) devices such as Opticom.

(L) Each detector rack shall be powered by the cabinet power supply and be connected to the power bus assembly by means of a 14-pin plastic MS circular connector with a twist lock connection.

8.37.10 Cabinet Test Switch Panel and Police Switch Panel

(A) A test switch panel shall be mounted on the inside of the main door. The test switch panel shall provide as a minimum the following:

- AUTO/FLASH SWITCH – In the FLASH position, power shall be maintained to the controller and the intersection shall be placed in flash. The controller shall not be stop-timed when in flash. Wired according to the current NEMA TS2 Standard, the MMU forces the controller to initiate the start-up sequence when exiting flash.
- STOP-TIME SWITCH – In the STOP-TIME position, the controller shall be stop-timed in the current interval.
- CONTROL EQUIPMENT POWER ON/OFF – This switch shall control the controller, MMU, and cabinet power supply AC power. Momentary test pushbuttons for all vehicle and pedestrian inputs to the controller are not required. The TS2 controller to be provided with the cabinet assembly shall provide vehicular and pedestrian call inputs from its keyboard while in the standard status display.

(B) A police switch panel shall be mounted inside the police access compartment located on the exterior of the cabinet door. The police switch panel shall contain the following:

- SIGNALS ON/OFF SWITCH – In the OFF position, power shall be removed from signal heads in the intersection. The controller shall continue to operate. When in the OFF position, the MMU shall not conflict or require reset.
- AUTO/FLASH SWITCH – In the FLASH position, power shall be maintained to the controller, and the intersection shall be placed in flash. The controller shall be stop-timed when in flash. Wired according to the current NEMA TS2 Standard, the MMU forces the controller to initiate the start-up sequence when exiting flash.

- AUTO/MANUAL SWITCH – Cabinet wiring shall include provisions for an AUTO/MANUAL switch and a momentary pushbutton or hand cord. The AUTO/MANUAL switch and pushbutton or hand cord shall be in each cabinet assembly.

(C) All toggle switches shall be heavy duty and rated 15-amps minimum. Single- or double-pole switches may be provided, as required.

(D) Any exposed terminals or switch solder points shall be covered with a non-flexible shield to prevent accidental contact.

(E) All switch functions shall be permanently and clearly labeled.

(F) All wire routed to the police door-in-door and test switch pushbutton panel shall be adequately protected against damage from repetitive opening and closing of the main door.

(G) All test switch panel wiring shall be connected to the main panel via a 24-pin plastic MS circular connector with a twist lock connection.

(H) All wiring from the main panel to the test switch panel shall be connected to the test switch panel via a 24-pin plastic MS circular connector with a twist lock connection.

8.37.11 Auxiliary Devices

(A) Load switches shall be solid state and shall conform to the requirements of the NEMA TS2 Standard.

(B) Signal load switches shall have a minimum rating of 10 amperes at 120 VAC for an incandescent lamp load.

(C) The front of the load switch shall be provided with six indicators to show the input signal and output signal from the controller to the load switch.

(D) Load switches shall be dedicated per phase. The use of load switches for other partial phases in not acceptable.

(E) A full complement of load switches shall be supplied with each cabinet to allow for maximum phase utilization for which the cabinet is designed.

(F) The flasher shall be solid state and shall conform to the requirements of the NEMA TS2 Standard.

(G) Flashing of field circuits for the purpose of intersection flash shall be accomplished by a separate flasher.

(H) The flasher shall be rated at 15 amperes, double-pole with a nominal flash rate of 60 FPM.

(I) All flash transfer relays shall meet the requirements of the NEMA TS2 Standard.

(J) The coil of the flash transfer relay shall be de-energized for flash operation.

(K) A full complement of flash transfer relays shall be supplied with each cabinet to allow maximum phase utilization for which the cabinet is designed.

(L) Each cabinet assembly shall be supplied with one (1) MMU as defined by the requirements of the NEMA TS2 Standard.

(M) Malfunction Management Units shall be a Type-16. The MMU shall be Econolite Model 1133-128 (EDI Model MMU2-16LEip) or approved equivalent.

(N) All BIUs shall meet the requirements of the NEMA TS2 Standard.

(O) A full complement of Econolite Model 160-1003-501 Bus Interface Units shall be supplied with each cabinet to allow for maximum phase and function utilization for which the cabinet is designed.

(P) Each BIU shall include power on, transmit, and valid data LED-type indicators.

(Q) The cabinet power supply shall meet the requirements of the NEMA TS2 Standard.

(R) The cabinet power supply shall provide LED indicators for the line frequency, 12 VDC, 12 VAC, and 24 VDC outputs.

(S) The cabinet power supply shall provide (on the front panel) jack plugs for access to the +24 VDC for test purposes.

(T) One (1) Econolite Model 1084-003 cabinet power supply shall be supplied with each cabinet assembly and shall be wired directly to the Power Bus Assembly via a fourteen (14) pin plastic MS circular connector with a twist lock connection.

8.37.12 Auxiliary Cabinet Devices - To Be Provided Per Customer Request

(A) Two (2) extra Ground and Neutral bus assemblies shall be mounted below the power auxiliary panel on the right lower side of the cabinet assembly.

(B) A six (6) position power strip assembly shall be installed on the upper left hand rails in the cabinet assembly. This power strip shall receive filtered power from CB3 in the power auxiliary panel via a 4 position terminal block, located near the power strip on the left side of the cabinet.

(C) An eight (8) position resistor panel assembly shall be installed on the right lower side of the cabinet and wired to the odd Vehicle phase red on the main panel.

(D) Two (2) battery shelves and covers shall be provided and installed on the lower left side of the cabinet for housing three (3) batteries.

(E) One (1) Hygrotherm unit and Humidity Control Heater shall be installed for monitoring and controlling condensation within the cabinet housing.

(F) The inside of the cabinet housing shall be painted WHITE.

(G) A Generator transfer switch assembly shall be installed and located on the lower right side of the cabinet.

(H) A 30A Generator Plug shall be installed in the right side of the cabinet with outside access to the Generator plug.

8.37.13 Testing and Warranty

(A) Each controller and cabinet assembly shall be tested as a complete entity under signal load for a minimum of 48 hours.

(B) Each assembly shall be delivered with a signed document detailing the cabinet final tests performed.

(C) The cabinet shall be assembled and tested by the controller manufacturer or an authorized local distributor to ensure proper component integration and operation.

(D) The controller and Malfunction Management Unit shall be warranted by the manufacturer against mechanical and electrical defects for a period of two (2) years from date of shipment. The manufacturer's warranty shall be supplied in writing with each cabinet and controller. Second party extended warranties are not acceptable.

(E) The cabinet assembly and all other components shall be warranted for a period of one (1) year from date of shipment.

(F) Any defects shall be corrected by the manufacturer or supplier at no cost to the CITY.

8.38.00 ACTUATED CONTROLLERS

8.38.01 General

(A) Compatibility - The local controller and cabinet shall be compatible with the CITY's existing computerized signal system which utilizes Econolite

equipment, or necessary modifications of the software and hardware shall be included to make both systems fully compatible.

(B) The controller shall conform to the latest NEMA specifications and shall provide for complete and full operation of eight phases from within either a TS1 or TS2 type 1 cabinet.

(C) Every controller supplied shall be the manufacturer's latest, first line production model tested and delivered by a domestic manufacturer who is regularly engaged in the construction of such equipment.

(D) Each controller shall be supplied with a complete set of operational and service manuals, wiring schematics, and parts layout up to a maximum of ten sets per order. Any controller for which these documents are not available is not a production model within the meaning of these STANDARDS AND SPECIFICATIONS.

(E) Each controller shall have a removable data module.

(F) Pre-emption. All actuated controllers shall be equipped to accommodate four EVP inputs and one railroad preemption input and include Transit Signal Priority control.

(G) The coordination unit shall be an internal function within each local controller and shall meet, as a minimum, the following functional requirements:

(1) The coordinator shall provide for at least four cycle lengths adjustable from 30 to 255 seconds, three offsets adjustable from 0 to 99 percent with offset correction by dwelling in coordinated phase or smooth transition, and four splits per cycle.

(2) Standard NEMA functions shall be used to control the intersection timing.

(3) The coordinator shall be capable of changing the controller's phase sequence upon command and telemetry failure.

(4) The coordinator shall be capable of setting the intersection free by loss of system sync, cycle/offset false commands, free command and telemetry failure.

(5) The coordinator shall be capable of setting the intersection into a flashing operation in accordance with the MUTCD, latest edition.

(6) The coordinator shall be capable to operate with telemetry module without additional hardware or software.

(7) Time-base coordination mode shall be provided as a backup with all standard coordination features available. At least two 7-day

programs shall be available with 50 additional holiday programs in the event of a master controller or communications failure. Time-base standby mode shall be programmable for an entire year with automatic daylight savings and leap-year changes.

8.39.00 MISCELLANEOUS HARDWARE

8.39.01 General

(A) Aluminum pedestal mounts shall be Pelco or approved equal.

(B) Mast arm brackets shall be Sky brackets or CITY approved equivalent and shall be installed 90 degrees to the roadway.

8.40.00 INSTRUCTIONS AND WIRING DIAGRAMS

A manual for the controller, containing service instructions, wiring diagrams, trouble-shooting procedures, etc. shall be provided in the controller cabinet.

8.41.00 SIGN SPECIFICATIONS

8.41.01 Sign Face Materials

All sign faces shall be fabricated from reflective sheeting, high-intensity prismatic grade or approved equal, that meets current MUTCD reflectivity requirements.

8.41.02 Sign Post Materials

All sign posts shall be fabricated from 12-gauge galvanized, perforated Telespar tubing or approved equal. The sign post assembly shall consist of a three foot (3') deep two inch by two inch (2" x 2") anchor sleeve and a one and three-quarter inch by one and three-quarter inch (1 ¾" x 1 ¾") by ten foot (10') post. See detailed drawing in Appendix.

8.41.03 Fire Lane Sign Specifications

Fire Lane parking prohibition signs shall meet the requirements of parking sign criteria in the MUTCD (latest edition).

8.42.00 ILLUMINATED STREET NAME SIGNS

8.42.01 General

Sign panel layouts and fixture shop drawings for internally illuminated signs and proposed mounting brackets/extensions shall be submitted as part of the bid. Final approval of submittals must occur prior to bid award, fabrication, and installation. A sample fixture shall be submitted to the CITY within ten (10) business days of request. Submittal of the shop drawings and sample fixture shall

be waived if the manufacturer has previously supplied approved signs to the CITY. All signs and fixtures shall conform to the concept designs as shown in the detail drawings. A source facility and manufacturing process inspection shall be allowed within five (5) business days of the CITY's request.

8.42.02 Sign Material

All signs shall be fabricated with new materials. No used or reconditioned sign blanks or outdated sheeting and/or pre-cut letters or numbers shall be used.

Internally illuminated signs shall be "Naim-Series-Inter Mark II, single-faced" logo and guide or approved equal. These may be fabricated or of the general type manufactured by Nu-Art Lighting or McCain Traffic Supply or approved equal. All signs on any single project or at any specific location shall be from the same manufacturer or fabricator unless otherwise specified by the TRAFFIC ENGINEER.

The face of the panel shall be "Lexan" or an approved type of sufficient thickness to permit minimum deflection, as certified by the manufacturer. If vinyl materials are used, verses silk screen applications, the material shall be diamond grade. All faces shall be of the same material.

The illumination source shall be LED lamps, powered by a twelve (12) Volt power supply. The internal illumination shall provide a uniform lighting on the sign message and background. A photoelectric control unit is required and shall be of the "hail-resistant" type and of the load rating for the intended use as shown on "Wiring Schematic". The photoelectric control shall be a unit that plugs into an EEI-NEMA twist lock receptacle mounted on top of the housing or traffic signal pole. Only one photoelectric control per intersection will be allowed. The single source photoelectric control unit shall power all units at any particular intersection. A wired 'pigtail' for the electrical service connection shall be supplied which extends three feet beyond the inboard side of the sign fixture.

The front sign panel of the case shall be hinged by a continuous hinge or extruded interlocking hinge, to provide access to the lamps. A weather-tight gasket shall be provided all around the sign fact to exclude dust and moisture. The latching devices shall be either screw type or latch type to provide a secure attachment of the sign face to the case.

8.42.03 Lettering

Street names and numbers shall be eight inch (8") Times Roman Bold in upper and lowercase display. The street prefix/suffix and hundred block designations shall be five inch (5") Times Roman Bold in upper and lowercase display.

8.42.04 Colors

Colors shall be as shown on the concept designs. The colors shall be white on teal for the street name and CITY logo areas, gray with a purple header above the street name with the CITY logo affixed to the top center.

8.42.05 Installation

The sign case shall be securely attached to the support structure using an Astro-Brac®, Sky Bracket® or an approved equal attachment device. Six foot (6') signs shall require a single bracket with eight foot (8') signs requiring two attachment devices. Close coordination is to be maintained between the sign fabricator and support fabricator to assure all attached devices are properly placed.

Illuminated street name signs shall be in lateral alignment in respect to the traffic signal mast arm for a true horizontal alignment in respect to the ground. The single faced signs shall mount in front of or in-line with the mast arm. All signs to be installed two feet (2') from the vertical pole as measured from the closest sign edge.

8.42.06 Wiring

Electrical service to the single source photo-electric control unit shall be connected to the luminaire circuit using a new cable of sufficient capacity to handle the number of fixtures required. Final Service connection to the electrical power source shall be independently fused at the source. Connections from the single photoelectric control unit to each sign fixture may utilize existing spare traffic signal wires/cables where available. Intersections that are controlled and maintained by CDOT shall include new wiring for all circuits and shall not use any spare traffic signal cables. A waterproofing cable grommet shall be installed at the cable exit port in the signal pole mast arm. No external wiring shall be visible for the approach of each respective sign.

8.42.07 Warranty

Both the sign fixture and the sign panel shall have a five (5)-year warranty against defects in material and workmanship.

TABLE OF CONTENTS

CHAPTER 9
TRENCHING, BACKFILLING, AND COMPACTING

Page

9.00.00 GENERAL 9-1

9.01.00 DESCRIPTION 9-1
9.02.00 QUALITY ASSURANCE 9-1
9.02.01 Compaction 9-1
9.02.02 Construction Staking 9-1
9.03.00 JOB CONDITIONS 9-2
9.03.01 Drainage and Groundwater 9-2
9.03.02 Sequencing 9-2
9.03.03 Underground Obstructions 9-3
9.04.00 MAINTENANCE AND CORRECTION 9-3
9.04.01 Trench Settlement 9-3

9.10.00 CONSTRUCTION SPECIFICATIONS 9-4

9.11.00 PREPARATION 9-4
9.12.00 UTILITY POTHOLING 9-4
9.13.00 EXCAVATIONS AND REMOVALS WITHIN EXISTING PAVED SURFACES 9-4
9.14.00 TRENCHING 9-5
9.15.00 PIPE BEDDING 9-7
9.16.00 BACKFILLING AND COMPACTION 9-7
9.17.00 FIELD QUALITY CONTROL 9-8

9.20.00 MATERIAL SPECIFICATIONS 9-9

9.21.00 STABILIZATION MATERIAL 9-9
9.22.00 BEDDING MATERIALS 9-9
9.23.00 TRENCH BACKFILL MATERIAL 9-10
9.24.00 FLOW-FILL/FLOWABLE FLY ASH BACKFILL 9-10
9.24.01 General 9-10
9.24.02 Compaction 9-11

CHAPTER 9
TRENCHING, BACKFILLING AND COMPACTING

9.00.00 GENERAL

9.01.00 DESCRIPTION

(A) This section covers excavation and trenching including drainage, dewatering, preparation of subgrades, pipe bedding, backfilling, compacting, and finish grading for underground pipe lines, service lines, and appurtenances.

(B) Reference detail drawing in the appropriate Chapter of these STANDARDS AND SPECIFICATIONS.

(C) Engineer of Record and CONTRACTOR shall comply with Senate Bill 18-167 utility requirements as specified in Chapter 1 of these STANDARDS AND SPECIFICATIONS.

(D) CONTRACTOR shall comply with all applicable OSHA requirements.

9.02.00 QUALITY ASSURANCE

9.02.01 Compaction

Soil compaction tests shall be performed in accordance with:

(A) ASTM D 698, Standard Method of Test for Moisture Density Relations of Soils

(B) ASTM D 2049, Standard Method of Test for Relative Density of Cohesionless Soils

9.02.02 Construction Staking

(A) Construction staking shall be performed with qualified, competent personnel under the direction of a Professional Land Surveyor registered in the State of Colorado.

(B) All survey notes and construction staking notes shall be entered into bound, hard cover field books. Cut sheets shall be provided upon request of the CITY INSPECTOR.

(C) Staking of the WORK shall be at fifty-foot (50') stations (maximum).

(D) Offsets shall be staked so that vertical and horizontal alignment may be checked.

(E) All survey data which is developed by the CONTRACTOR or the DEVELOPER's surveyor in performing surveys which are required by the WORK shall be available to the CITY for examination throughout the construction period.

9.03.00 JOB CONDITIONS

9.03.01 Drainage and Groundwater

(A) If groundwater is anticipated, the CONTRACTOR/DEVELOPER shall acquire a CDPHE dewatering permit. All construction dewatering shall be in accordance with CDPHE permitting requirements.

(B) All excavations and trenches shall be kept free from excess groundwater during construction.

(C) Any water which is encountered in the trench shall be removed to the extent necessary to provide a firm subgrade to permit joints to be made in the dry and to prevent the entrance of water into the pipeline. Stabilization material may be required to provide a firm base.

(D) Surface run-off shall be diverted as necessary to keep excavations and trenches free from water during construction.

(E) The excavation or trench shall be kept free from water until the structure or pipe to be installed therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

(F) Water shall be prevented from entering into previously constructed pipe.

(G) The pipe under construction shall not be used for dewatering.

9.03.02 Sequencing

(A) Pipeline installation shall be performed within two hundred (200) linear feet of trench excavation. If construction is occurring in an open field, this distance may be increased at the CITY INSPECTOR's discretion.

(B) Initial trench backfill shall be performed within fifty (50) linear feet of pipeline installation. If construction is occurring in an open field, this distance may be increased at the CITY INSPECTOR's discretion.

(C) In residential areas with driveways, the above distances may be decreased at the discretion of the CITY ENGINEER to minimize impacts to driveways.

(D) Where excavation is a hazard to automotive or pedestrian traffic, the amount of open trench and the duration of that opening is to be

minimized. The CONTRACTOR shall coordinate the amount and duration of road closures with the TRAFFIC ENGINEER.

(E) No open cutting or micro trenching shall occur at signalized intersections without the prior expressed approval of the CITY ENGINEER.

(F) The CITY ENGINEER has the sole discretion to deny any saw cutting, open trenching, or micro trenching impacting public or private sidewalks, or driveways.

9.03.03 Underground Obstructions

(A) The CONTRACTOR shall field verify all drawings of record information obtained from the CITY or other affected utility company.

(B) The CONTRACTOR shall notify each utility owner and request utilities to be field located by surface reference at least seventy-two (72) hours prior to trenching or excavation.

(C) In situations where conflicts may exist, the CONTRACTOR shall expose and verify the size, location, and elevation of underground utilities and other obstructions sufficiently in advance of construction to permit changes to be made to the construction drawings.

(D) In the case of a conflict, the CONTRACTOR shall notify the CITY ENGINEER and the affected utility company, the proposed WORK may then be modified by the DEVELOPER and after the CITY ENGINEER approval.

(E) Existing improvements, adjacent property, utilities, trees, and plants that are not to be removed shall be protected from injury or damage resulting from the CONTRACTOR's operations. If damage should occur, the CONTRACTOR shall make repair such that damaged materials are restored in original or better condition, as directed by the CITY ENGINEER, utility or property owner in question.

(F) If the CONTRACTOR removes any underground obstructions, the following shall apply:

1. Underground obstructions shall be removed and replaced according to current standards and specifications.

2. The disturbed area in which the underground obstruction was located shall be restored to original or better condition.

9.04.00 MAINTENANCE AND CORRECTION

9.04.01 Trench Settlement

The CONTRACTOR shall maintain and repair all trench settlement and make necessary repairs to pavement, sidewalks, or other structures which may be damaged as a result of backfill settlement. CONTRACTOR shall warrant WORK for a period of two (2) years after final completion and acceptance of the WORK.

9.10.00 CONSTRUCTION SPECIFICATIONS

9.11.00 PREPARATION

(A) Topsoil shall be stripped from areas which are to be disturbed by construction and stockpiled.

(B) Topsoil shall be segregated from non-organic trench excavation material and debris.

9.12.00 UTILITY POTHOLING

(A) Utility potholing, also called test-holing, incudes, but is not limited to, mechanical, hydraulic or vacuum borehole excavating to locate underground utility facilities.

(B) Utility potholing shall not damage the utility facilities. Any damage to utilities shall be repaired by the CONTRACTOR.

(C) When the CONTRACTOR will be conducting utility potholing within the RIGHT-OF-WAY, the CONTRACTOR shall obtain a PERMIT.

(D) The CONTRACTOR shall adhere to all requirements of the PERMIT regarding traffic control and pavement patching.

(E) The CONTRACTOR shall repair any distress to the pothole patches according the requirements of the PERMIT.

9.13.00 EXCAVATIONS AND REMOVALS WITHIN EXISTING PAVED SURFACES

(A) Sawcutting of the existing pavement is required prior to final patching.

(B) Minimum patching depths are as follows:

ARTERIAL STREETS –	9” FULL DEPTH
COLLECTOR STREETS -	7” FULL DEPTH
LOCAL STREETS -	5” FULL DEPTH

In the event existing asphalt thickness exceeds these minimums, the patch depth shall match existing.

(C) Asphalt patching materials shall be according to the requirements for hot mix asphalt in Chapter 6 of these STANDARDS AND SPECIFICATIONS.

(D) All trench backfilling shall be accomplished by using flow-fill/flowable flyash material conforming to Section 9.24.00 of these STANDARDS AND SPECIFICATIONS.

(E) No dimension of existing pavement less than 3 feet shall be left between the new patch and existing lip of gutter (5 feet for concrete). On Arterial or Collector streets, no side of a patch shall fall within 2 feet of the existing wheel path. Patches within 2 feet shall require the removal of additional pavement to meet this requirement.

(F) All patches will be 4 sided.

(G) **All patches will require the removal and replacement of an additional 2 feet of asphalt on each side of the trench to compensate for the vertical shear of the trench walls.** See the standard details in these STANDARDS AND SPECIFICATIONS.

(H) Patches shall not be less than 4 feet in any direction unless previously approved.

(I) Patches in concrete pavement shall be from joint to joint.

(J) Steel trench plates to cover excavations open to traffic shall be secured in place by staking, cold patch, hot mix asphalt or keying in to existing asphalt.

(K) Steel trench plates shall be allowed from October 1 to May 1 only with prior written permission of the TRAFFIC ENGINEER, and will not be allowed within seven (7) days of forecasted snow.

(L) All existing traffic control devices, including traffic marking paint, thermoplastic markings, and traffic signal loop detectors shall be replaced prior to acceptance of the patching.

(M) Excavations that result in a patch that exceeds 8 feet in each direction shall require the use of a spreader box. Patches exceeding 12 feet in width and 200 feet in length shall require the use of a self- propelled paver.

(N) Patches in existing paved areas shall be warranted for a period of 1 year from the date of acceptance, unless the patch is part of WORK associated with a PIA, in which case the period will be 2 years.

(O) Final surface tolerances shall not exceed 1/4 inch as measured with a 10-foot straight edge.

9.14.00 TRENCHING

(A) Trenches shall be excavated by open-cut methods, except where boring or tunneling is indicated, shown on drawings, or approved by the CITY ENGINEER.

(B) Trench width shall be maintained to within three inches (3") of that specified on plans.

(C) Care shall be used when operating mechanical equipment in locations where it may cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground.

(D) Mechanical equipment shall be designed and operated in such a manner that the bottom elevation of the trench can be controlled with uniform trench widths and vertical sidewalls which extend from the bottom of the trench to an elevation one foot (1') above the top of the installed pipe.

(E) Trench alignment shall be sufficiently accurate to permit pipe to be aligned properly with the proper clearance between the pipe and the sidewalls of the trench as required by the pipe material. The trench sidewall shall not be undercut in order to obtain clearance.

(F) CONTRACTOR shall over-excavate a minimum of six inches (6") below the bottom of the pipe wherever the trench bottom is rock, shale, or other unsuitable material. Over-excavation shall be backfilled and compacted with acceptable granular material. Granular material shall conform to Section 9.22.00 of these STANDARDS AND SPECIFICATIONS.

(G) Preparation of Trench Bottom:

1. Trench bottoms shall be graded uniformly to provide clearance for each section of pipe.

2. Loose material, water, and foreign objects shall be removed from the trench.

3. The CONTRACTOR shall provide a firm subgrade which is suitable for application of bedding material.

4. Wherever unstable material is encountered in the bottom of the trench, said material shall be over-excavated to a depth suitable for construction of a stable subgrade. The depth suitable for construction of a stable subgrade shall be approved by the CITY ENGINEER. The over-excavation shall be backfilled with stabilization material and compacted as required by the CITY ENGINEER. Stabilization material shall conform to Section 9.21.00 of these STANDARDS AND SPECIFICATIONS.

(H) Stockpiling Excavated Materials:

1. Suitable material for backfilling shall be stockpiled in an orderly manner at a minimum of two feet (2') from the edge of the trench.

2. Excess excavated materials not suitable or not required for backfilling shall be removed from the site and properly disposed of.

3. Excavated material shall not be stockpiled against existing structures or appurtenances.

4. Excavated materials containing any hazardous materials shall be disposed of at an approved site in accordance with an abatement plan to be prepared by the DEVELOPER/engineer or other qualified professional in accordance with all federal, state, and local ordinances.

(I) Limiting Trench Widths:

1. Trenches shall be excavated to a width necessary to provide working space required by the pipe material between the pipe and the trench walls for proper pipe installation, joining, and bedding.

2. The maximum trench width at an elevation twelve inches (12") above the top of the installed pipe shall be the pipe diameters of the pipe plus 24 inches, or thirty inches (30") whichever is greater. If the width of the trench, twelve inches (12") above the top of the pipe, exceeds the maximum allowable trench width, a higher strength pipe or special pipe bedding shall be provided as required by soil-loading conditions and as approved by the CITY ENGINEER.

9.15.00 PIPE BEDDING

(A) Placement:

1. Bedding material shall be distributed and graded to provide uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. Pipe shall not be supported by the bells.

2. To prevent lateral displacement, granular bedding material shall be deposited and compacted uniformly and simultaneously on each side of the pipe.

(B) Ground water barriers shall be designed and constructed in such a manner to prevent passage of water through bedding material for the full depth of the granular bedding material and the full width of the trench. Ground water barriers shall be built according to the details on the construction drawings.

9.16.00 BACKFILLING AND COMPACTION

(A) Trenches shall be backfilled promptly after the pipe has been installed and inspected. Backfill around manholes and valve boxes shall be compacted with hand-operated equipment.

(B) Backfill material shall be deposited in uniform horizontal layers which may not exceed six inches (6") (compacted depth) in all areas. Other thickness may be used with the prior written approval of the CITY ENGINEER.

(C) Methods and equipment which are appropriate for the backfill of material shall be employed. Backfill equipment or backfilling methods which transmit damaging shocks to the pipe shall not be used.

(D) Compaction shall not be performed by jetting or water settling.

(E) If compaction cannot be obtained with job excavated material, trench backfill material shall be imported.

(F) Topsoil shall be replaced to the depth of stripping over all areas which are to receive vegetation.

(G) Excess excavated materials and materials not suitable for backfill shall be removed from the site.

9.17.00 FIELD QUALITY CONTROL

(A) Field Compaction Control:

1. Field tests will be conducted to determine compliance of compaction methods with specified density in accordance with ASTM D 2922 (Tests for Density of Soil and Soil-Aggregate in Place by Nuclear Methods).

2. Compaction tests shall be performed at a depth of two feet (2') above the top of the pipe and in one-foot (1') vertical increments up to the finish grade.

3. Compaction tests shall be performed at least once every one hundred (100) linear feet as measured along the length of the pipe.

4. If the CITY ENGINEER determines that reliable and uniform results are produced by the CONTRACTOR's construction techniques, the frequency of testing may be changed to one every two hundred feet (200').

(B) Compaction shall be to the following minimum densities (reference ASTM D 698 or AASHTO T 99 unless otherwise indicated):

1. Barrier Material - 95 Percent of Maximum Standard Density.

2. Pipe Bedding:

   a. Carefully Compacted Select Soil -
   95 Percent of Maximum Standard Density

3. Trench Backfill:

   a. Paved roadways, sidewalks, and other areas - 95 Percent of Maximum

Standard Density

b. Gravel Roadways - 95 Percent of Maximum Standard Density

c. Fields and All Other Areas - 90 Percent of Maximum Standard Density

d. Under Footings, Foundations, Structures, 100 Percent of Maximum Standard Density or in Conformance with the Approved Soils Report and Recommendations

(C) Moisture Content:

1. All compacted backfill shall be within two percent (2%) (plus or minus) of the optimum moisture content of the soil as determined by ASTM D 698, unless otherwise specified by a geotechnical report.

2. Water shall be added to the material or the material shall be harrowed, disced, bladed, or otherwise worked to insure a uniform moisture content, as specified.

9.20.00 MATERIAL SPECIFICATIONS

9.21.00 STABILIZATION MATERIAL

(A) If the existing soil in the trench bottom is judged to be unsuitable by the CITY ENGINEER, the top six inches (6") of the pipe subgrade shall be removed and replaced with a stabilization material.

Stabilization material shall conform to ASTM D 448, according to Table 9.21.00:

TABLE 9.21.00
Stabilization Material

Size	Percent Passing
2 Inch	100
1-1/2 Inch	90-100
1 Inch	20-55
3/4 Inch	0-15
3/8 Inch	0-5

(B) Geotextiles used for erosion control, drainage and silt fence shall conform to Section 700 of the CDOT Standard Specifications for Road and Bridge Construction.

9.22.00 BEDDING MATERIALS

(A) Granular Material. Squeegee material conforming to Table 9.22.00:

TABLE 9.22.00
Bedding Material

Sieve Size	Percent Passing
3/8 Inch	100
No. 4	50-100
No. 8	0-45
No. 16	0-30
No. 50	0-6
No. 200	0-3

(B) Select Soil. Excavated material which is free from rocks, clods, and stones greater than one-and-one-half inches (1-1/2") in any dimension and which meets other requirements of trench backfill material.

9.23.00 TRENCH BACKFILL MATERIAL

(A) Trench backfill material shall be placed from a point twelve inches (12") above the pipe to twelve inches (12") below the ground surface or to the bottom of the pavement subgrade, whichever is greater.

(B) Trench backfill material shall be either soil excavated from the trench or imported soil.

1. Any soil used for trench backfill shall be free from frozen matter, stumps, roots, brush, other organic matter, cinders or other corrosive material, hazardous material, debris, and any rocks or stones which are larger than six inches (6") in any dimension. Rocks or stones which are larger than three inches (3") in any dimension shall not be placed within one foot (1') of pavement subgrade or within one foot (1') of the finished surface of unpaved areas or within one foot of the pipe.

2. If imported soil is used for trench backfill it shall meet CDOT specifications for Class 2 structure backfill.

9.24.00 FLOW-FILL/FLOWABLE FLY ASH BACKFILL

9.24.01 General

When required or approved by the CITY ENGINEER, and at the expense of the CONTRACTOR/DEVELOPER, the following materials may be used in lieu of structure backfill (Class 1 and Class 2) or to backfill culvert pipes, storm sewer pipes, and utility cuts.

TABLE 9.24.00

FLOW-FILL

Ingredients	Pounds Per Cubic Yard
Cement	50
Coarse Aggregate (AASHTO No. 57 or 67)	1700
Fine Aggregate Water (AASHTO M6)	1845
Water (39 Gallons)	325 (or as needed for proper consistency)

FLOWABLE FLY ASH BACKFILL

Ingredients		Pounds Per Cubic Yard
Class C Fly Ash	(ASTM C618)	200-400
Class F Fly Ash	(ASTM C618)	1,600-1,800
Water (96 Gallons)		800 (or as needed for proper consistency)

No flowable fly ash backfill will be used to backfill abutments.

9.24.02 Compaction

Compaction of flowable fly ash backfill will not be required if material meeting the above requirements is used.

The maximum layer thickness for flowable fly ash backfill shall be three feet. Additional layers shall not be placed until the flowable fly ash backfill has lost sufficient moisture to be walked on without indenting more than two inches. Damage resulting from placing flowable fly ash backfill in layers that are too thick or from not allowing sufficient time between placement of layers shall be removed and replaced.

TABLE OF CONTENTS

CHAPTER 10

STREET LIGHTING

Page

10.00.00 INTRODUCTION 10-1

10.01.00 SCOPE 10-1
10.02.00 SYSTEM COMPOSITION 10-1
10.03.00 MODIFICATION OF DESIGN CRITERIA 10-1

10.10.00 DESIGN STANDARDS 10-1

10.11.00 GENERAL 10-1
10.12.00 ILLUMINANCE STANDARDS 10-1
10.13.00 PLACEMENT OF STREETLIGHTS 10-1
10.13.01 Lighting System Layout 10-1
10.13.02 Medians 10-2
10.13.03 Overhead Utilities 10-2
10.13.04 Roundabouts 10-2
10.14.00 STREETLIGHT POLES 10-3
10.14.01 General 10-3
10.14.02 Bases 10-3
10.14.03 Setbacks 10-3
10.14.04 Mounting Height 10-3
10.14.05 Luminaire Arms 10-3
10.14.06 Decorative Poles 10-3
10.14.07 Luminaires 10-4
10.14.08 Spare Equipment 10-4
10.15.00 ELECTRICAL SYSTEM 10-4
10.15.01 Standards 10-4
10.15.02 Distribution System 10-4
10.15.03 Conduit 10-4
10.15.04 Junction and Pull Boxes 10-5
10.15.05 Circuits 10-5
10.15.06 Cable 10-5
10.15.07 Break-Away Connectors 10-6
10.15.08 Grounding 10-6
10.15.09 Power Supplies 10-6
10.15.10 Secondary Service 10-7
10.15.11 Pole Numbering 10-7
10.16.00 PLAN REQUIREMENTS 10-7
10.16.01 General 10-7
10.16.02 Private Improvements 10-7
10.16.03 Sheet Size 10-7
10.16.04 Types of Sheets in Plans 10-8
10.16.05 Cover Sheet 10-8
10.16.06 General Notes Sheet 10-9
10.16.07 Street Lighting Plan Sheet(s) 10-9

10.16.08 Wiring Diagram Sheet(s) *10-10*
10.17.00 PRE-CONSTRUCTION REQUIREMENTS AND STEPS 10-10
10.17.01 Meter Locations *10-10*
10.17.02 Builders Call Line *10-10*
10.17.03 Meter Address *10-10*
10.17.04 Staking Approval *10-10*
10.17.05 Material Submittals *10-10*

10.20.00 CONSTRUCTION REQUIREMENTS 10-11

10.21.00 GENERAL REQUIREMENTS 10-11
10.21.01 General *10-11*
10.21.02 Scope *10-11*
10.21.03 Codes and Standards *10-11*
10.21.04 Modification of Specifications *10-11*
10.21.05 Appurtenances *10-11*
10.21.06 Incidental Work and Parts *10-11*
10.21.07 Existing Lighting *10-12*
10.22.00 PERMITS 10-12
10.22.01 Permits and Inspections *10-12*
10.22.02 Owner's Building Permit *10-12*
10.23.00 ELECTRICAL SERVICE 10-12
10.24.00 MAINTENANCE WORK 10-12
10.25.00 BASES 10-13
10.25.01 Screw-in Anchor Bases *10-13*
10.25.02 Concrete Base Staking *10-13*
10.25.03 Reinforcing *10-13*
10.25.04 Conduit *10-13*
10.25.05 Positioning *10-14*
10.25.06 Anchor Bolts *10-14*
10.25.07 Placing Concrete and Curing *10-14*
10.25.08 Finishing *10-14*
10.25.09 Backfilling *10-14*
10.26.00 CONDUIT INSTALLATION 10-15
10.26.01 Size *10-15*
10.26.02 Conduit Markers *10-15*
10.26.03 Cleaning *10-15*
10.26.04 Couplings and Bends *10-15*
10.26.05 Depth *10-16*
10.26.06 Outlets *10-16*
10.26.07 External Conduit on Structure *10-16*
10.26.08 Trenching *10-17*
10.26.09 Plowing *10-17*
10.26.10 Boring *10-18*
10.27.00 PULL AND JUNCTION BOXES 10-18
10.27.01 Position *10-18*
10.27.02 Bedding *10-18*
10.27.03 Excavation and Backfill *10-18*
10.27.04 Concrete Pads *10-19*
10.27.05 Cable Hooks *10-19*
10.27.06 Additional Boxes *10-19*

10.28.00 POWER SUPPLY INSTALLATION 10-19
10.29.00 CIRCUIT WIRING 10-19
10.29.01 General *10-19*
10.29.02 Cable Pulling *10-19*
10.29.03 Taping and Sealing *10-20*
10.29.04 Splices *10-20*
10.29.05 Coiling *10-20*
10.29.06 Labeling *10-20*
10.30.00 CABLE-IN-DUCT INSTALLATION 10-20
10.31.00 STREETLIGHT POLE INSTALLATION 10-21
10.31.01 General *10-21*
10.31.02 Protection and Cleaning *10-21*
10.31.03 Pole Installation *10-21*
10.31.04 Hand Hole Orientation *10-21*
10.31.05 Cover Skirt *10-21*
10.31.06 Luminaire Arm Installation *10-21*
10.31.07 Luminaire Installation and Adjustment *10-22*
10.31.08 LED Lamp Installation *10-22*
10.32.00 ELECTRICAL CONNECTIONS 10-22
10.33.00 GROUNDING 10-23
10.34.00 SYSTEM TESTING 10-23
10.35.00 BURN TEST 10-23
10.36.00 MAINTENANCE INFORMATION 10-23
10.37.00 AS-BUILT PLANS 10-24
10.38.00 FINAL CLEAN UP 10-24

10.40.00 MATERIALS AND EQUIPMENT 10-24

10.41.00 SCOPE 10-24
10.42.00 STREETLIGHT POLES 10-24
10.31.08 Poles *10-24*
10.42.02 Luminaire Arms *10-25*
10.43.00 BASES 10-25
10.43.01 Screw-In Anchor Bases *10-25*
10.43.02 Flowable Backfill *10-25*
10.43.03 Concrete *10-25*
10.43.04 Reinforcing Steel for Concrete Boxes *10-25*
10.43.05 Anchor Bolts *10-25*
10.44.00 LUMINAIRES 10-26
10.44.01 General *10-26*
10.44.02 Cobra Head Luminaires *10-26*
10.44.03 Post-Top Luminaire *10-26*
10.44.04 LED Lamps *10-26*
10.45.00 CONDUIT 10-27
10.45.01 Conduit Type *10-27*
10.45.02 Polyvinyl Chloride (PVC) *10-27*
10.45.03 High Density Polyethylene (HDPE) *10-27*
10.45.04 Galvanized Rigid Steel (GRS) *10-27*
10.45.05 Cable-In-Duct *10-28*
10.46.00 PULL AND JUNCTION BOXES 10-28
10.47.00 CABLE 10-28

10.47.01 General *10-28*
10.47.02 Distribution Cable *10-29*
10.47.03 Pole and Bracket Cable *10-29*
10.48.00 BREAK-AWAY FUSED AND NON-FUSED CONNECTORS 10-29
10.49.00 SPLICES 10-29
10.50.00 POWER SUPPLIES 10-29
10.50.01 General *10-29*
10.50.02 Cabinets *10-30*
10.50.03 Photoelectric Cells *10-30*
10.50.04 Contractors, Relays, and Terminal Blocks *10-31*
10.50.05 Circuit Breakers *10-31*
10.50.06 Lightning Arrestors *10-31*
10.51.00 SPARE EQUIPMENT 10-31

CHAPTER 10
STREET LIGHTING

10.00.00 INTRODUCTION

10.01.00 SCOPE

These criteria shall be adhered to for the design of all street lighting systems to be installed in the RIGHT-OF-WAY of major and minor arterial roadways. The TRAFFIC ENGINEER shall be responsible for determining the scope of a street lighting system.

10.02.00 SYSTEM COMPOSITION

The street lighting system shall consist of one (1) or more power supplies, distribution systems, poles, luminaires, and other appurtenances required to provide a complete, operable system. Components of the system shall conform to Section 10.40.00 of these STANDARDS AND SPECIFICATIONS.

10.03.00 MODIFICATION OF DESIGN STANDARDS

These criteria are established to provide uniform procedures to aid the DEVELOPER in preparing improvement plans for projects in the CITY. These criteria are not to be a rigid set of rules that would restrict the DEVELOPER from utilizing creative or original design; however, these criteria may be modified only with prior authorization by the TRAFFIC ENGINEER.

10.10.00 DESIGN STANDARDS

10.11.00 GENERAL

These STANDARDS AND SPECIFICATIONS shall be followed when specifying the type and placement of equipment for a street lighting system.

10.12.00 ILLUMINANCE STANDARDS

The street lighting design and layout shall be based on the illuminance criteria for continuous roadway lighting in the latest edition of the American National Standard Practice for Roadway Lighting, Illuminating Engineering Society of North America (ANSI/IESNA RP-8).

10.13.00 PLACEMENT OF STREETLIGHTS

10.13.01 Lighting System Layout

The street lighting system layout required is dictated by the street classification and is typically continuous. Photometric analysis shall be utilized to calculate the theoretical spacing of streetlights to meet the illumination standards for each street classification. The TRAFFIC ENGINEER should be consulted to determine the appropriate street

classification. The location of streetlights shall conform to the standards below.

Several values are needed to complete the photometric analysis. A lighting loss factor (LLF) of 0.70 shall be utilized. The minimum maintained average illuminance values and the average-to-minimum illuminance ratios listed below are based on the 2000 Edition of the Standard Practice. The values for the R2/R3 pavement surface reflective classification are used.

TABLE 10.10.03
Illumination Standards

Roadway Classification	**Area Type**	**Minimum Maintained Average Illumination (foot-candles)**	**Average-to-Minimum Illuminance Uniformity Ratio**
Arterial	Commercial	2.0	3:1
	Intermediate	1.7	3:1
	Residential	1.3	3:1
Collector	Commercial	1.7	4:1
	Intermediate	1.3	4:1
	Residential*	0.9	4:1

*Use Collector-Residential for local residential roadways

The actual spacing of streetlights should be the possible spacing nearest to the calculated theoretical spacing. At locations where additional lighting may be beneficial, such as around curves or at intersections, pole spacing may be reduced to improve the lighting levels.

10.13.02 Medians

Streetlights can be installed in raised medians with straight curb faces that have a minimum width of four feet (4') between backs of curbs, and in mountable medians that have a minimum width of twelve feet (12') between edges of pavement. Streetlights located in medians shall be installed as close as possible to the center of the median. All streetlight poles in medians shall be a minimum of thirty feet (30') behind the median nose.

10.13.03 Overhead Utilities

Streetlights should be located to have a minimum clearance of eight feet (8') from all overhead utilities.

10.13.04 Roundabouts

At a roundabout controlled intersection, a minimum of two (2) streetlights should be located around the circular roadway, diagonally across from

each other. On arterial type roadways, a minimum of four (4) streetlights should be placed around the outside of the circulatory roadway. The spacing between the poles should be approximately equal to achieve uniform lighting throughout the roundabout. Streetlights on the approaches to roundabouts should also be considered on multi-lane approaches, in areas with high traffic volumes, or where pedestrian traffic is expected.

10.14.00 STREETLIGHT POLES

10.14.01 General

Streetlight pole types, differentiated by mounting height and luminaire arm length, are illustrated in the Standard Details. Equipment to be utilized should be selected based on the criteria listed below.

10.14.02 Bases

Screw-in anchor bases are not allowed. All streetlight poles shall have a break-away base.

10.14.03 Setbacks

All streetlight poles shall have a minimum setback of three feet (3') measured from the back of curb to the center of the pole base on a curbed street. The minimum setback for a non-curbed street shall be six feet (6') measured from the edge of pavement to the center of the pole base. The minimum setback may be reduced to two feet (2') in raised medians.

10.14.04 Mounting Height

Luminaires should be installed at a maximum mounting height of thirty-five (35') to forty feet (40') above arterial and collector roadways. Poles mounted on structures, such as bridges and retaining walls, may require special lengths as not to exceed the maximum mounting height.

10.14.05 Luminaire Arms

Luminaire arms should be selected to position the luminaire over the traveled way for greatest utilization of available light. The arms should be oriented 90-degrees, or perpendicular, to the traveled way. Arm lengths should be selected in order to position the luminaires in a straight line when looking down the roadway with the typical arm length designated at 10 feet (10').

10.14.06 Decorative Poles

Decorative streetlight poles are allowed only with the authorization of the CITY ENGINEER.

10.14.07 Luminaires

All luminaires shall utilize LED lamps. Other types of lamps may be utilized with the authorization of the CITY ENGINEER. All luminaries must be fully shielded (emit no direct up-light) and should at a minimum meet the requirements of the IESNA classification for cutoff light distribution.

10.14.08 Spare Equipment

For large projects, the CITY will require the CONTRACTOR to supply spare streetlight poles, luminaire arms, luminaires, and break-away base assemblies. One (1) spare assembly should be included for every forty (40) poles to be installed. When non-standard or decorative poles are used, the CITY may require additional spare streetlight pole assemblies.

10.15.00 ELECTRICAL SYSTEM

10.15.01 Standards

The electrical system shall comply with the National Electrical Code (ANSI/NFPA 70), the National Electrical Safety Code (ANSI C2), and the service standards issued by the appropriate electrical utility company that will be supplying power to the street lighting system. The DEVELOPER shall coordinate and verify the location of proposed feed points with the utility company to ensure availability of service.

10.15.02 Distribution System

The following criteria shall govern the design of the electrical distribution system.

10.15.03 Conduit

The distribution system shall be underground in two inch (2") diameter Schedule 80 PVC conduit or HDPE conduit. Cable-in-duct may be installed for projects in mostly unpaved areas. If conduit is to be installed on a structure, galvanized rigid steel (GRS) conduit should be used. GRS conduit shall be attached to the structure with conduit hangers as shown in the Standard Details.

Except where it crosses under a street, the conduit shall be behind the back of curb or outside the edge of pavement in the RIGHT-OF-WAY. The conduit should be installed at a constant offset from the back of curb or edge of pavement at the same distance as the pole setback, unless a common trench is being used. The minimum setback from the street to the center of the conduit should be the same as that specified for street light poles except in medians, where conduit setback may be closer to the back of curb to avoid landscaping. The setbacks may have to be adjusted in places to avoid storm sewers, utility conflicts, or other obstructions.

In unpaved areas, conduit can be trenched or plowed. Conduit shall be bored under all sidewalks, drives, and streets unless otherwise approved by the CITY ENGINEER. Boring under streets shall be perpendicular to the roadway or the shortest possible crossing distance.
The length of conduit is calculated by adding the center to center distances between equipment. All of the center to center distances should be subtotaled and multiplied by 102% to allow for bending of conduit to avoid obstructions.

10.15.04 Junction and Pull Boxes

Junction or pull boxes shall be installed at each light pole location and where splices in the distribution cable are required outside the pole base or where sharp 90-degree bends in conduit are required. The distance between boxes and/or streetlight poles shall not exceed three hundred feet (300') to facilitate the pulling of cable. Boxes must be installed at least three feet (3') away from streetlight poles. The installation of boxes in sidewalks should be avoided while the installation of boxes in streets and driveways is prohibited. The minimum setback from the street to the center of boxes should be the same as specified for street light poles. Type 1 junction boxes shall be used if one or two (1 or 2) conduits enter/exit the box. Type 2 junction boxes shall be used where three or four (3 or 4) conduits enter/exit the box. A Class 1 pull box shall be located adjacent to each four-circuit power supply, or where five or more (5+) conduits enter/exit the box.

10.15.05 Circuits

All circuits shall be two hundred forty volts (240V). Distribution cable shall be sized so that the voltage drop does not exceed five percent (5%) at any point in the system. The DEVELOPER is required to submit voltage drop calculations. Three conductor (3c) cables shall be used for each circuit, which are no larger than No. 4 AWG and no smaller than No. 8 AWG.

Each street lighting circuit shall be contained in a separate conduit, except for the conduit raceway between a four-circuit power supply and the adjacent class 1 pull box. For that raceway, two (2) conduits will be required. The distribution cable for each of the lighting circuits shall be routed through one of these two conduits into the pull box, and then routed out to the first pole for each circuit in separate conduits. Double taps on a circuit breaker are not allowed.

10.15.06 Cable

Street lighting cable is permitted in traffic signal conduit runs and pull boxes, but not within conduits and pull boxes designated for traffic signal interconnect. Street lighting circuits are to enter a traffic signal pole through the adjacent traffic signal pull box. The distribution cables are to be spliced in the traffic signal pole base hand hole access (if necessary) and

run up the traffic signal pole to the luminaire fixture. Street lighting cable shall not run through (or terminate in) the traffic signal controller cabinet.

The length of distribution cable is calculated by adding the center to center distances between all equipment on a circuit. The length of all cable should be subtotaled and multiplied by 102% to allow for bending. Five feet (5') of slack should be added at each light pole base or power supply. Slack should also be added for junction and pull boxes; two feet (2') at each Type 1 junction box, three feet (3') at each Type 2 junction box, and five feet (5') at each Class 1 pull box.

Pole wiring from the distribution cables to each luminaire shall be two conductor No. 10 AWG (2c #10) pole and bracket cables. The length of pole and bracket cable for each pole is calculated by adding the nominal pole height, the length of the luminaire arm and five feet (5') of slack. This quantity is multiplied by two for poles with dual luminaires.

10.15.07 Break-Away Connectors

Each distribution cable shall be connected to the corresponding pole and bracket cable using a break-away connector. Two (2) fused connectors should be used for the hot leads, and one (1) non-fused connector should be used for the ground as shown in the Standard Details.

10.15.08 Grounding

All streetlight poles shall be bonded together to form a continuous system. A No. 6 AWG bare solid copper ground wire enclosed in one inch (1") PVC conduit shall be securely attached to a ground rod with a galvanized grounding clamp at each concrete street light pole base, at each direct buried base, and at each power supply base.

10.15.09 Power Supplies

As shown in the Standard Details, one-circuit or four-circuit or eight-circuit power supplies shall be utilized. Power supply bases should be located within the RIGHT-OF-WAY and be adjacent to and behind the sidewalk, or at least ten feet (10') from the back of curb to the center of the power supply where no sidewalk exists. In locations where no curb exists, the power supply should typically be placed more than ten feet (10') from the edge of pavement to the center of the power supply if possible. Each power supply should be located at least 10 feet (10') from its secondary service point. When the location of the power supply has been finalized and the secondary service point has been verified with the electrical utility company, the CITY will provide the DEVELOPER with an identification number for each proposed power supply. When a power supply contains a photoelectric cell, it shall be oriented to the north unless headlights from southbound traffic will be directed at the photoelectric cell, then it should be oriented to the east.

10.15.10 Secondary Service

A 2-1/2 inch (2½") Schedule 80 PVC conduit with a pull string shall be installed from the power supply to the base of the secondary service point (utility pole, secondary pedestal, or pad-mount transformer) as designated by the electrical utility company. The conduit should be installed in a straight horizontal line in accordance with the Standard Details. Junction or pull boxes are not permitted in the conduit run between the power supply and secondary service point unless authorized by the electrical utility company. The electrical utility company shall designate who will supply and install the power cable.

10.15.11 Pole Numbering

Streetlight poles shall be numbered using the power supply identification number followed by the circuit number and pole number. For example, the first pole on circuit number 1, from power supply number 6K05 should be labeled as 6K05-1-1. The second pole on the circuit shall be labeled 6K05-1-2.

10.16.00 PLAN REQUIREMENTS

10.16.01 General

This section governs the preparation of engineering plans for a street lighting project. The street lighting plans shall include all information necessary to build and check the design of a street lighting system. For new developments, the street lighting plans shall be submitted with the public improvement construction plans (if any) and shall clearly show public street and stormwater drainage improvements and utilities in a deemphasized manner. The cover sheet for the plans shall be signed and sealed by a Professional Engineer registered in the State of Colorado responsible for preparing the plans. The signed and sealed plans shall be submitted to the CITY ENGINEER for review and approval prior to construction.

10.16.02 Private Improvements

If any private improvements are shown on the PLANS, they shall be clearly defined and marked as such. An appropriate note shall be included on the drawings stating that these private improvements will not be maintained by the CITY. This section is not intended to imply that private improvements will be allowed within the RIGHT-OF-WAY.

10.16.03 Sheet Size

The full-size plan sheet size for PLANS shall be twenty-two inches by thirty-four inches (22"x34"). Full-size and half-size plans are required for all submittals and may be submitted in electronic form. All sheets in a given set shall be the same size.

10.16.04 Types of Sheets in Plans

The streetlight PLANS shall consist of the following:

- Cover Sheet (if necessary)
- General Notes
- Street Lighting Plan Sheet(s)
- Wiring Diagram(s)
- CITY of Westminster's Street Lighting Standard Drawings
- Traffic Control Details (if necessary)

Each sheet should contain proper project identification, the type of sheet, a sheet number, including the individual sheet number and the total number of sheets, and dates of when the plans were originally prepared and all revisions.

10.16.05 Cover Sheet

A cover sheet is not required if street lighting is included as a part of a plan set for a larger improvement project. If necessary, the cover sheet shall include the following information:

(A) The project title, centered at the top of the sheet as follows:
CITY OF WESTMINSTER, COLORADO
PUBLIC WORKS & UTILITIES DEPARTMENT/ENGINEERING DIVISION
STREET LIGHTING IMPROVEMENTS FOR
[Name of Roadway], from [start point] to [end point]
Engineering Project Number [when applicable]
Date
The CITY logo shall appear to the left of the title block.

(B) An index of the sheets included in the plans.

(C) A list containing the name and telephone number of each utility company and the State One-Call System.

(D) The name, address, and telephone and fax numbers of the Design Engineer.

(E) The name, address, and telephone and fax numbers of the OWNER/DEVELOPER, where applicable.

(F) A vicinity map adequately showing the project location in relation to major streets and the section in which it is situated, with a north arrow and appropriate scale.

(G) A signature block to be signed and sealed by the Professional Engineer registered in the State of Colorado responsible for preparing the PLANS.

10.16.06 General Notes Sheet

This sheet should contain a legend of symbols that apply to all sheets, a recapitulation of quantities table, and a list of general notes to the CONTRACTOR including any project specific notes. The lighting design calculations and standards should also be included in the project specific notes.

10.16.07 Street Lighting Plan Sheet(s)

The street lighting plan sheet(s) shall include the following information:

(A) One or more plan sheets adequately showing the street lighting system in relation to the streets and adjacent properties, with a north arrow, and a bar scale at a minimum scale of one inch (1") equals fifty feet (50'), unless a larger scale is specified by the CITY ENGINEER.

(B) All existing and proposed utilities such as power, gas, water, telephone, cable, sanitary sewer, storm sewer, and other items shall be accurately shown according to the best available information in the records of the owner of the facility, or field location, and shall be identified as to type, size, material, etc., as may be applicable. Existing utilities should be shown in gray.

(C) The base plans shall show all existing and proposed easements and RIGHT-OF-WAY information. All existing and known proposed improvements within fifty feet (50') each side of the RIGHT-OF-WAY and one hundred feet (100') beyond the project limits shall be shown at their proper locations unless otherwise approved or required by the CITY ENGINEER. These improvements shall include items such as street pavement, curbs and gutters, sidewalks and driveways, storm and sanitary sewers, water mains and fire hydrants, utility poles and pedestals, trees and shrubs, fences and walls, buildings, and similar items, and shall be identified as to type, size, material, etc., as may be applicable. Irrelevant items may be omitted for new developments. Existing items should be shown in gray. New non-street lighting items may be shown with a thin black line. Future non-street light items may be shown with a dashed line.

(D) Street lighting equipment should be identified by station and offset. Street centerline stations should be shown and marked at one hundred-foot (100') intervals. If station and offset are not indicated, the locations of proposed street lighting equipment should be referenced from existing features that appear on the base plans, such as the back of curb, edge of pavement, utility poles, etc.

(E) Each item to be constructed or installed for the project should be legibly noted. Minimum font size shall be 0.125 inch on a 22" x 34" sheet size. Each power supply should be labeled with the identification number assigned by the CITY. Street light poles should

also be labeled with the power supply identification number, circuit number, and pole number as described in Section 10.15.11.

(F) There should be a table listing the pole number, station, offset, and luminaire arm lengths for all proposed poles. There should also be a table listing the box number, station, offset, and type of box for all proposed junction and pull boxes. All proposed equipment shall be listed in the order in which it is located in the plans.

10.16.08 Wiring Diagram Sheet(s)

This sheet should contain wiring diagrams (overall schematics of the street lighting system) for each power supply. The center to center distance between street light equipment should be indicated on the diagram. A summary table for each circuit should also be included on this sheet indicating the conductor size, circuit length, input amperage, percent voltage drop, circuit assignment at the power supply, and circuit breaker trip rating.

10.17.00 PRE-CONSTRUCTION REQUIREMENTS AND STEPS

10.17.01 Meter Locations

DEVELOPER shall coordinate the Meter Location(s) with Xcel Energy or United Power.

10.17.02 Builders Call Line

The Contractor will submit a Builders Call Line (BCL) applications with Xcel Energy. The CITY billing address for the BCL application is: Finance Department, City of Westminster, 4800 W. 92nd Ave, Westminster, CO 80031.

Applications with United Power should be coordinated with United Power.

10.17.03 Meter Address

Prior to submission of the BCL application, contact the CITY's Engineering Division at 303-658-2120 for the meter address before pulling an electrical PERMIT.

10.17.04 Staking Approval

Prior to installation, contact the CITY's Engineering Division to inspect the street light location stakes.

10.17.05 Material Submittals

Prior to ordering equipment, contact the CITY's Engineering Division for submittal of all the materials required in the project. The City will not be responsible for the purchase of non-approved materials associated with

the street lighting project. Only approved submitted materials will be accepted.

10.20.00 CONSTRUCTION REQUIREMENTS

10.21.00 GENERAL REQUIREMENTS

10.21.01 General

These standards shall be followed when specifying the type and placement of equipment for a street lighting system.

10.21.02 Scope

This section governs the construction of all bases and the installation of all luminaires, poles, conduits, cables, and other material and equipment as required to complete the street lighting system as shown on the PLANS, and the Standard Details, and as specified in the IMPROVEMENT AGREEMENTS.

10.21.03 Codes and Standards

All work and material shall be in accordance with the latest requirements of the Illuminating Engineering Society of North America (IESNA), National Electrical Code (NEC), National Electrical Safety Code (NESC), Standards of the American Society of Testing Materials (ASTM), American Standards Associations (ASA), National Electrical Manufacturers Association (NEMA), and all applicable local ordinances. The standard referred to shall be the latest revision of said standard as amended at the time of the Advertisement, except as noted on the PLANS and/or the IMPROVEMENTS AGREEMENT.

10.21.04 Modification of Specifications

These specifications may be modified or deleted by appropriate items in the PLANS or by written authorization by the CITY ENGINEER.

10.21.05 Appurtenances

All appurtenances shall be installed as shown on the PLANS, or as specified in the IMPROVEMENTS AGREEMENT. Any deviations must be established by the CONTRACTOR and authorized by the CITY ENGINEER.

10.21.06 Incidental Work and Parts

The WORK incidental to the installation of a street lighting system shall be performed in accordance with these STANDARDS AND SPECIFICATIONS. All incidental parts, which are not shown on the PLANS and which are necessary to complete the street lighting system, shall be supplied and

installed by the CONTRACTOR to the satisfaction of the CITY ENGINEER at no cost to the CITY.

10.21.07 Existing Lighting

Existing lighting shall be maintained in effective operation by the CONTRACTOR except for shutdowns with approval from the CITY ENGINEER for alterations or final removal. The CONTRACTOR shall take all precautions necessary to minimize the downtime of the existing street lighting systems to be modified.

10.22.00 PERMITS

10.22.01 Permits and Inspections

The CONTRACTOR shall contact the Department of Public Works & Utilities before any WORK begins to notify the CITY ENGINEER of the construction schedule and to request project inspections. The CONTRACTOR is responsible for obtaining all necessary PERMITS from the CITY, and is responsible for all associated costs, before the WORK can begin.

10.22.02 Owner's Building Permit

The CONTRACTOR is responsible for obtaining the owner's building permit from the CITY's Building Division before electrical service can be delivered to a power supply. The CONTRACTOR shall contact the CITY's Building Division for an electrical inspection when each power supply is ready for operation. The CONTRACTOR will obtain an address from the CITY's Engineering Division for each power supply, which the CONTRACTOR shall use when dealing with the electrical utility company.

10.23.00 ELECTRICAL SERVICE

The CONTRACTOR is responsible for contacting the electrical utility company in advance to schedule delivery of service to each power supply. The CITY shall pay the electrical utility company's fees to deliver electrical service. The CONTRACTOR shall be billed for all electrical utility service charges until the entire project is substantially complete and the burn test is successfully completed. After those milestones, the electrical service can be transferred to the CITY upon request by the CONTRACTOR.

10.24.00 MAINTENANCE WORK

The CONTRACTOR is responsible for making all repairs and replacements, including downed poles, damaged or cut cables, and burnt out LEDs/lamps, to the street light system, regardless of the cause or responsible party, until the work is determined by the CITY to be substantially complete.

10.25.00 BASES

10.25.01 Screw-in Anchor Bases

The CITY does not allow screw-in type anchor bases.

10.25.02 Concrete Base Staking

The CONTRACTOR is responsible for verifying the correct line and grade of all concrete bases prior to installation. The CONTRACTOR shall stake the location of all street lighting poles and power supplies to be installed. The CITY INSPECTOR shall inspect the staking prior to any excavation and/or construction and final location of all equipment is at the sole discretion of the City. Minor relocation of equipment to avoid conflicts may be allowed with the approval of the CITY ENGINEER.

10.25.03 Reinforcing

All concrete bases shall be of the size and type shown in the Standard Details, including all reinforcing steel. Reinforcing steel for concrete bases shall be accurately cut and bent to the dimensions and shapes shown on the Plans. Cutting and bending tolerances for reinforcing steel shall be in accordance with the Concrete Reinforcing Steel Institute's *Manual of Standard Practice*. Flame-cutting of uncoated reinforcing steel may be permitted. Reinforcing steel shall be protected from damage at all times.

When placed in the work and before concrete is placed, reinforcing steel shall be free from dirt, oil, paint, grease, loose mill scale, thick rust, any dried mortar, and other foreign substances. A thin layer of powdery rust may remain. Reinforcing bars shall be positively secured against displacement. The bars shall be firmly tied at alternate crossings or closer. The steel shall be spot welded or tied in the correct position with proper clearance maintained between the forms and the reinforcement. The CONTRACTOR shall construct the unit as shown on the PLANS.

Measurements to reinforcing steel will be made to the centerline of bar, except where the clear distance from face of concrete is shown on the PLANS.

Splicing of bars shall not be allowed.

10.25.04 Conduit

PVC conduits and conduit bends should be set in the forms for concrete bases. Pole and power supply bases shall have separate conduits for exiting/entering cables and a separate one inch (1") conduit for the ground wire. The direction of the exiting conduits and the orientation of the power supply shall be as shown in the PLANS.

Conduit set in concrete bases shall extend approximately three inches (3") above the base vertically and a minimum of three inches (3") outside the base horizontally underground.

10.25.05 Positioning

The bottom of all concrete bases shall rest on firm ground. Forms shall be true to line and grade. The top of the base for street light poles, except raised bases, shall be finished to curb or sidewalk grade, or as directed by the CITY ENGINEER. Forms shall be rigid and securely braced in place. Conduits and anchor bolts shall be placed in proper position, to proper heights, and held in place by means of a template until the concrete sets. Conduits shall be covered before concrete is poured to prevent concrete from entering the conduits.

10.25.06 Anchor Bolts

All portions of the anchor bolts extending above the base shall be threaded. Anchor bolts shall align with the bolt holes on the shoe base. Anchor bolts shall be provided with two (2) hex head nuts, flat washer, and lock washer. One nut shall be installed on each anchor bolt to be embedded in the concrete base, to within 1/8" above flush with the top of the base.

10.25.07 Placing Concrete and Curing

Concrete shall be placed and cured in accordance with Chapter 7 of these STANDARDS AND SPECIFICATIONS.

10.25.08 Finishing

The exposed portions of the base shall be finished to present a neat appearance. Finishing should be done with the positioning jig in place. If the jig must be removed for finishing, it shall be re-installed immediately after finishing and left in place throughout the cure period. A safety device (traffic cone, Type I barricade, etc.) shall be installed over each pole base immediately after finishing and remain in place until the pole is installed. Prior to installing the pole, the positioning jig shall be removed and loose concrete cleaned from around the anchor bolts and conduits.

10.25.09 Backfilling

Cinders, broken concrete, broken rock, or other hard or undesirable material shall not be used for backfilling around the finished base. The backfill material shall be placed in layers not to exceed six inches (6") deep, and each layer shall be thoroughly compacted to the approximate density of the adjacent material before the next layer is placed.

10.26.00 CONDUIT INSTALLATION

10.26.01 Size

Conduit shall be installed as shown in the PLANS. The size of the conduit used shall be as shown on the PLANS but is typically 2 inch in diameter. It shall be the privilege of the CONTRACTOR, at no cost to the CITY, to use larger size conduit if desired, as approved by the CITY ENGINEER. Where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted.

10.26.02 Conduit Markers

Wherever a conduit passes beneath a curbed street, aluminum conduit markers shall be installed in the curb immediately over the conduit location. Conduit markers shall be furnished by the CONTRACTOR as detailed in the Standard Details and shall be installed in the top of the curb by drilling the curb and epoxying the conduit marker in place. Conduit markers are subsidiary to the installation of conduit.

10.26.03 Cleaning

The ends of all conduits shall be well-reamed to remove burrs and rough edges. All conduits shall be cleaned and swabbed prior to installation of cable. All conduit ends shall have Conduit End Bells. Field cuts shall be made square and true so that the ends will butt or come together for the full diameter thereof. The end of each conduit run shall be covered to prevent water or debris from entering the conduit while the system is being constructed. Existing underground conduit to be incorporated into a new system and GRS conduits shall be cleaned with a mandrel and blown out with compressed air.

10.26.04 Couplings and Bends

An approved factory coupling shall be used for connection of the HDPE conduit to a 90˚ factory PVC elbow or between two lengths of HDPE conduit.

Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, conduit bends shall be made without crimping or flattening, using the longest radius practicable and utilizing an appropriate conduit bending tool. The conduit shall be installed continuous from outlet to outlet or as otherwise shown on the PLANS.

With respect to HDPE conduit, no couplings or joints will be allowed at intermediate points unless approved by the CITY ENGINEER.

10.26.05 Depth

The conduit may be directional bored to minimize disruption to the existing improvements or may be plowed or trenched. Conduit shall be installed under pavement sections at a depth not less than 24 inches (24"); and where laid in trenches in unpaved areas, conduit shall be laid to a depth of 24 to 36 inches (24" to 36") below natural ground level or finished grade.

10.26.06 Outlets

At all outlets, conduit shall enter from the direction of the run. PVC conduit bends shall enter all junction or pull boxes from below the box and shall extend into the box a minimum of 4 inches (4") as shown on the PLANS.

GRS conduits may enter a pull or junction box from the side. The side of the box shall be drilled per the manufacturer's recommendations. The hole shall be no more than one-half inch (½") larger than the conduit. The gap between the box and conduit shall be filled with sealing compound.

10.26.07 External Conduit on Structure

GRS conduit shall be used when conduit is to be installed externally on structures. Conduit on structures will include conduit on bridges, retaining walls or other structures, and shall be installed as shown on the PLANS or as directed by the CITY ENGINEER. The final location of all conduit and junction boxes shall be approved by the CITY ENGINEER before installation begins.

Conduit shall not be attached to prestressed concrete girders or prestressed, precast concrete deck panels. The conduit shall be secured to the concrete with clamps at no more than 5-foot intervals. Concrete anchors shall be in accordance with federal specification FF-S-325, Group II, Type 4, Class I, and shall be galvanized in accordance with ASTM A 153, B 695-91 Class 50, or constructed of stainless steel. The minimum embedment in concrete shall be 1-3/4 inches (1 ¾").

If it is necessary to anchor the conduit to steel bridge members, the attachment method shall not involve drilling, grinding, or welding. Attachment method to steel members shall be approved by the CITY ENGINEER.

Expansion fittings shall be installed at each end of a bridge and each location where the conduit crosses a bridge expansion joint. The expansion fitting shall provide a minimum movement in either direction as shown on the PLANS or as specified by the CITY ENGINEER.

Clamps, concrete anchors, expansion fittings, and any hardware or material required for conduit installation on structures shall be at no cost to the CITY.

10.26.08 Trenching

Trenches shall be excavated to a maximum width of six inches (6”) and deep enough to provide the minimum cover for conduits as shown in the Standard Details. Conduit shall be allowed to "snake" in the trench, but there shall be no sharp bends and if two or more conduits are placed in a common trench, the conduits shall not cross each other. If the bottom of the trench is in rock or rocky soil, the conduit shall be placed on a six inch (6") protective layer of clean, tamped backfill material.

Trenches shall be backfilled as soon as practical after the installation of conduit, but after inspection of the trench by the CITY ENGINEER or designee. Backfill material installed within six inches (6”) of the conduit shall be free of rock or other solid material that might cause mechanical damage to conduit. The backfill material shall be placed in layers not to exceed 6 inches (6”) deep, and each layer shall be thoroughly compacted to the approximate density of the adjacent material before the next layer is placed.

Red burial tape imprinted with "CAUTION - BURIED CABLE BELOW" shall be installed in all trenches at approximately 1/3 to 1/2 of the depth of the trench. The four to six inches (4” to 6”) of backfill material directly below finished grade shall be topsoil. All disturbed areas shall be restored to the satisfaction of the CITY INSPECTOR.

10.26.09 Plowing

Conduit may be installed by plowing in unpaved areas. The equipment used for plowing conduit is designed specifically for that purpose with the power and versatility to easily and accurately bury the various sizes of conduit under all normal soil conditions. This equipment places the conduit without twisting, kinking, or damaging the material in any way. The vibrating unit shall be attached to a tractor unit in such a manner that the tractor does not dampen the vibration. The cable way and guides shall be smooth, free of obstructions and sharp edges and shall not cause bending of the conduit at shorter than the minimum bending radius recommended by the manufacturer, nor cause excessive strain to the conduit.

Conduit reels may be mounted on the tractor or conduit unreeled along the proposed route before plowing in such a manner to allow as direct a line as possible to the trench to avoid unnecessary bending of the conduit or rubbing of the conduit against the reel. The plow shall not be backed onto the conduit. If an underground obstruction is encountered, the plow shall be lifted out of the ground and the obstruction removed.

Conduit may be installed utilizing the pull plow method if approved by the CITY ENGINEER.

After installation of conduit by plowing, the disturbed earth shall be leveled and, if necessary, compacted by a device approved by the CITY ENGINEER. Ends of conduit shall be capped immediately after cutting to prevent moisture and debris from entering the conduit. Red burial tape imprinted with "CAUTION - BURIED CABLE BELOW" shall be installed in all trenches at approximately 1/3 to 1/2 of the depth of the trench. All disturbed areas shall be restored to the satisfaction of the CITY INSPECTOR.

10.26.10 Boring

Pavement shall not be disturbed without the written permission of the CITY ENGINEER and then only in the event insurmountable obstructions are encountered. Conduit shall be placed under existing pavement by boring. The CONTRACTOR shall complete the boring as to maintain minimum permissible clear distances, both horizontally and vertically, from all underground utilities. Boring pits shall be kept two feet (2') clear of the edge of any type of pavement wherever possible. Boring alignment shall be perpendicular to the curb line in order to achieve the shortest possible crossing distance. Excessive use of water such that pavement might be undermined or subgrade softened, will not be permitted. The CONTRACTOR shall at all times and for the entire length of the boring alignment be able to demonstrate the horizontal and vertical position of the alignment. All disturbed areas shall be restored to the satisfaction of the CITY INSPECTOR. Boring may be used instead of trenching at all other locations.

10.27.00 PULL AND JUNCTION BOXES

10.27.01 Position

Pull and junction boxes shall be installed as shown on the PLANS, Standard Details, or as directed by the CITY ENGINEER. The top surface of all pull or junction boxes shall be flush with surfaced areas and approximately one inch above earth or sodded areas. Pull or junction boxes shall not be installed in sidewalk ramps and wherever possible, should be installed outside of the accessible path.

10.27.02 Bedding

All boxes shall have one-half inch (½") clean crushed aggregate or other porous material for a minimum depth of twelve inches (12") below the box for drainage.

10.27.03 Excavation and Backfill

The excavated opening outside the junction box shall be wide enough to allow compaction of the backfill material. Cinders, broken concrete, broken rock or other hard or undesirable material shall not be used for backfilling. The backfill material shall be placed in layers not to exceed six

inches (6") deep, and each layer shall be thoroughly compacted before the next layer is placed. All disturbed areas shall be restored to the satisfaction of the CITY INSPECTOR.

10.27.04 Concrete Pads

A pull or junction box placed in an unpaved area shall have a concrete pad around the perimeter as shown on the PLANS. Concrete for the pad shall be per Section 10.43.03. The concrete shall be reinforced with welded wire fabric. Concrete pads will not be required for boxes installed in concrete.

10.27.05 Cable Hooks

Each Class 1 Pull Box shall be equipped with cable hooks as shown on the PLANS. Cable hooks shall be galvanized steel or brass with a minimum diameter of 3/8 inch (3/8") and a minimum length of five inches (5").

10.27.06 Additional Boxes

Additional pull or junction boxes may be installed when approved by the CITY ENGINEER. If it becomes necessary to increase the excavation depth and extend the box, no direct payment will be made.

10.28.00 POWER SUPPLY INSTALLATION

The power supply, including the cabinet, photoelectric cell, contactors, circuit breakers, lightning arrestor, and any other required materials or equipment shall be constructed and installed as shown on the PLANS or as directed by the CITY ENGINEER. The CONTRACTOR shall coordinate his activities with the electrical utility company to ensure delivery of power to the power supply when and where required. The cabinet shall be cleaned of wrapping, shipping material, dirt, grease, etc. Scratches, abrasions or other surface damage shall be repaired to like new condition. The photoelectric cell shall be oriented to the north or to the east.

10.29.00 CIRCUIT WIRING

10.29.01 General

Installation of wiring shall be in accordance with the PLANS, these STANDARDS AND SPECIFICATIONS and appropriate articles of the NEC.

Distribution cables shall be continuous and unspliced from the control panel to the handhole base of the first light pole.

10.29.02 Cable Pulling

Cable shall be pulled with minimal dragging on the ground or pavement. Frame mounted pulleys or other suitable devices shall be used for pulling cables out of conduits into pull boxes. If needed, wire pulling lubricant or other approved lubricant shall be used to facilitate pulling cable in

conduits. All cable to be installed in one conduit shall be pulled by the CONTRACTOR in one operation, and all ends shall be taped to exclude moisture and shall be so kept until the splices are made or terminal appliances attached.

10.29.03 Taping and Sealing

Ends of spare conductors shall be taped. Tape shall be Scotch (3M) No. 33+ "Electrical Tape" or approved equivalent. After cables are installed all conduit ends shall be sealed around the cables with a readily workable, soft, sealing compound. The compound shall be workable at 30˚ F and shall not melt or run at temperatures up to 175˚ F.

10.29.04 Splices

Underground cable splices shall be made in a pull or junction box. Splices in the distribution cable will only be permitted where circuits branch or tee. Tee splices shall be made with split bolt connectors or an approved equivalent. All splices shall be protected with a waterproof resin splice kit installed in accordance with the manufacturer's recommendations.

10.29.05 Coiling

All cables passing through a pull or junction box shall be coiled once around the inside of the box to allow for splicing and connecting wires in the future. Wiring within power supplies and boxes shall be neatly arranged and laced up.

10.29.06 Labeling

All circuits shall be properly labeled in all power supplies and boxes by means of round brass or aluminum identification tags with a minimum thickness of 0.1 mil attached to the cables with copper wire. The ends of the copper wire should be wrapped with electrical tape. Circuits shall be labeled with the power supply ID number and the circuit number.

10.30.00 CABLE-IN-DUCT INSTALLATION

All applicable portions of the conduit installation and circuit wiring sections apply to cable-in-duct installation. Cable-in-duct may be installed by boring, trenching, or plowing operations. Cable-in-duct runs shall be continuous without splice between the control panel, pole bases, and junction or pull boxes. Cable-in-duct shall extend far enough to provide the required amount of cable slack at all terminations or connections. For concrete bases, rigid conduit of sufficient size to facilitate the pulling of cable-in-duct shall be cast in the base as shown on the PLANS. The cable-in-duct shall be installed through the rigid conduit in the base. The plastic duct of the cable-induct is to be terminated six inches (6”) above the bottom of junction or pull boxes and bases, leaving the cables exposed for connection. All terminations of this plastic duct are beveled free from any sharp

edges or burrs. The insulation of the electrical conductor may not be damaged when cutting the duct.

10.31.00 STREETLIGHT POLE INSTALLATION

10.31.01 General

Streetlight poles and luminaires shall be installed as shown on the PLANS and Standard Details, IMPROVEMENTS AGREEMENT, or as directed by the CITY ENGINEER.

10.31.02 Protection and Cleaning

Streetlight poles are to be kept dry and out of the weather until time for erection. The manufacturer's protective paper wrapper may be removed for inspection upon receipt from the manufacturer. Poles and luminaires shall be cleaned of dirt, grease, etc. Scratches, abrasions, or other surface damage shall be repaired to like new condition.

10.31.03 Pole Installation

Streetlight poles shall be fastened to concrete bases using galvanized hardware with a break-away base. The pole shall be checked for plumb, minor corrections made using galvanized or cadmium plated steel shim stock, the nuts tightened, and the removable bolt covers installed.

10.31.04 Hand Hole Orientation

Hand holes in the pole shall be oriented so that they are 180˚ from the direction of oncoming traffic. In a median, the hand holes should be oriented 180˚ from one direction of oncoming traffic, facing either north or east, for all poles installed in medians.

10.31.05 Cover Skirt

If directed by the CITY ENGINEER, an aluminum cover skirt must be installed around all four (4) sides of the base plate if a gap of more than one inch (1") is visible between the bottom face of the base plate and the finished grade. The cover skirt is to be made of two solid sheets of aluminum, alloy designation 3003-H14, which are field cut and shaped to fit flush against the base plate and extend down to the finished grade. The aluminum sheets should overlap each other and be fastened together with stainless steel self-tapping screws.

10.31.06 Luminaire Arm Installation

Luminaire arms shall project from the street side of the pole and be perpendicular to the roadway. Install a one inch (1") rubber grommet

around the hole at the top of the light pole for the cable entrance. Sufficient lengths of pole and bracket cable shall be run inside the length of the street light pole shaft, out through the grommet at the top of the pole, and through the arm. Cables shall not be pinched when arms are attached to poles.

For poles with dual luminaires, different color pole and bracket cables shall be run to each luminaire to indicate the directional orientation of each luminaire. When looking at the hand hole, red cables shall be run to the luminaire on the right-hand side of the pole, and black cables shall be run to the luminaire on the left-hand side of the pole.

10.31.07 Luminaire Installation and Adjustment

Cobra head luminaires shall be installed on the slipfitter at the end of the luminaire arm. To give proper illumination on the roadway, the frontal view of the luminaire should be parallel to the grade of the road surface, while in the side view the luminaire should be horizontal. Post-top luminaires not equipped with terminal blocks shall be connected to the pole wiring with approved butt connectors.

10.31.08 LED Lamp Installation

The installation date shall be marked on the base of the LED lamp prior to installing it in the luminaire housing.

10.32.00 ELECTRICAL CONNECTIONS

Each distribution cable shall be connected to the corresponding pole and bracket cable in each pole base using a fused or non-fused break-away connector as shown on the PLANS. Two (2) fused connectors should be used for the hot leads, and one (1) non-fused connector should be used for the ground. Each break-away connector should allow two (2) cables to be attached to the terminal on the line side. The load side of the fused connectors should allow one (1) cable to attach to the terminal for single luminaires and two cables (2) for dual luminaires on a single pole.

Two (2) pole and bracket cables are to be run from the load side of the fused connectors to each luminaire on the pole. One (1) pole and bracket cable is also to be run from the load side of the non-fused connector to the grounding lug on the street light pole. The connectors shall be installed convenient to the hand hole in the street light pole. One foot of surplus cable shall be coiled at the line side of each connector and on the load side of each connector. Connectors shall be installed with the fuse or ground slug attached to the load side of the connector.

From the load side of the non-fused connector, the ground wire shall be fastened to the factory installed ground lug in the base of the light pole by a 3/8" ring terminal and 3/8" - 16 x 3/4" long hex bolt.

10.33.00 GROUNDING

At each concrete base, a ground rod shall be driven in the pull box adjacent to the pole. At each power supply base, a ground rod shall be driven in the same trench as the 3" conduit, or if approved in the adjacent pull box, for the secondary service connection. The completed ground rod installation and connection to the ground wire shall not be backfilled until the power supply passes inspection by the CITY's Building Division electrical inspector. The grounding clamp connection and the listing mark on the rod must be visible for inspection.

The ground rod shall be copper coated to meet NEC requirements, not less than one-half inch (½") in diameter, and ten feet (10') in length. Ground rods shall be driven to a minimum depth of twelve inches (12") below the finished surface. If subsurface conditions exist which prohibit the placement of the ground rod in a vertical position, the rod may be driven at an oblique angle, not to exceed 45-degrees from vertical, or when authorized by the CITY ENGINEER, buried in a trench at least thirty inches (30") deep. The driven ground rod shall be connected to the grounding lug by a No. 6 AWG copper wire attached to the rod with a galvanized grounding clamp. The ground wire is to be run through a one inch (1") diameter conduit in the base.

10.34.00 SYSTEM TESTING

The CONTRACTOR is responsible for testing the completed street lighting system. Prior to acceptance by the City, the CONTRACTOR shall notify the CITY ENGINEER for an inspection as soon as the system(s) is (are) ready. After a power supply is energized, the resistance to ground shall be tested. The CONTRACTOR shall provide a suitable measuring device capable of measuring ground resistance from 0 to 1,200 ohms for the resistance test. The resistance test shall be performed by the CONTRACTOR in the presence of and documented by the CITY ENGINEER. The ground rod shall have a resistance to ground of 25 ohms or less. If the resistance is more than 25 ohms, the CONTRACTOR shall install additional ground rods which are bonded to the first ground rod, until the required resistance is achieved at no cost to the CITY.

10.35.00 BURN TEST

All street lighting system elements shall function properly as a complete system for a minimum period of thirty (30) days before acceptance by the CITY. The thirty (30) day period shall be cyclical and initiated by the CITY ENGINEER. Any malfunction observed or recorded shall stop the test period for the entire system as of the time of the malfunction. A period shall start when the malfunction has been repaired to the satisfaction of the CITY ENGINEER. After the burn test is completed, the street light system(s) must remain in operation if the street is open to vehicle traffic.

10.36.00 MAINTENANCE INFORMATION

Before acceptance of the work, the CONTRACTOR shall furnish the CITY ENGINEER four copies of the manufacturers' written instructions for maintenance

and operation of all lighting equipment and wiring diagrams of the installation or system. At a minimum, the manufacturer's instructions shall include documented, organized instructions, wiring and component layout diagrams, and parts lists with part numbers.

10.37.00 AS-BUILT PLANS

Prior to acceptance of the work, the CONTRACTOR shall submit marked-up or corrected plans showing in detail all construction changes, especially the location and depth of conduit. The DEVELOPER will produce as-built plans from the CONTRACTOR's red-lined plans.

10.38.00 FINAL CLEAN UP

Before final acceptance, the CONTRACTOR shall restore to a condition equal to or better than that existing prior to construction, for all property, both public and private, within, adjacent to and beyond the limits of construction that have been disturbed or damaged while executing the work. This includes, but is not limited to, existing curb and gutter, sidewalk, pavement, drainage structures, irrigation systems, street lighting, and traffic signal equipment. All unpaved areas damaged during construction shall be restored to the original condition. Unless otherwise directed, grassy areas which were originally sodded shall be re-sodded. Restoration work shall be at the CONTRACTOR's expense. All restoration work shall be acceptable to the CITY INSPECTOR.

10.40.00 MATERIALS AND EQUIPMENT

10.41.00 SCOPE

This section governs the furnishing of all luminaires, poles, conduits, cables, and other material and equipment supplied by the CONTRACTOR, as required, to complete the street lighting system as shown on the Plans, the Standard Details, and IMPROVEMENTS AGREEMENT. All lighting equipment shall be of new stock unless the contract provides for relocation of existing units or use of units furnished by others. New equipment and material shall be of the best grade and shall meet the approval of the CITY ENGINEER.

10.42.00 STREETLIGHT POLES

10.42.01 Poles

The type of pole and length of luminaire arm shall be as specified on the PLANS. It is the responsibility of the fabricator to verify and attest that the material sizes proposed are structurally adequate and in full compliance with these STANDARDS AND SPECIFICATIONS.

The base shall be cast with four (4) holes to receive the anchor/connecting bolts and tapped holes for attaching the four (4) cast aluminum alloy removable bolt covers provided for each pole. The bolt covers shall attach to the upright portion of the body of the base. The bolt circle diameter is

provided in the standard drawings. If poles are to be placed on existing bases or structures with anchor bolts in place, the CONTRACTOR shall furnish poles with a shoe base to fit the anchor bolt spacing.

10.42.02 Luminaire Arms

The luminaire arm assembly for arterials and major collectors shall be a one piece arm and shall be either and 3 bolt simplex mount plate, a slipfit davit ("goose neck" type) or a slipfit arm as show in the standard drawings.

10.43.00 BASES

10.43.01 Screw-In Anchor Bases

Screw-in anchor bases are not allowed.

10.43.02 Flowable Backfill

All flowable backfill shall be mix design as described in Chapter 9 of these STANDARDS AND SPECIFICATIONS.

10.43.03 Concrete

Concrete construction shall be in accordance with Chapter 7 of these STANDARDS AND SPECIFICATIONS.

10.43.04 Reinforcing Steel for Concrete Bases

All reinforcing steel shall meet the requirements of steel bars for concrete reinforcement. AASHTO specifications, when referenced, will control the physical properties, chemical properties, and handling and storage of the material, except as otherwise specified herein or shown on the Plans. Unless otherwise specified, reinforcement shall be deformed bars in accordance with AASHTO M 31, AASHTO M 42, or AASHTO M 53. Bars in accordance with AASHTO M 42 and M 53 shall be in straight lengths only. Splicing of bars is not allowed. Upon request, CONTRACTOR shall provide documentation of reinforcing steel that shall include the steel manufacturer's certified mill test report showing complete chemical and physical test results for each heat.

10.43.05 Anchor Bolts

Anchor bolts shall be steel with 50,000 PSI minimum yield. Anchor bolts shall be threaded for the length of the bolt that is to be exposed. The anchor bolts shall be hot dipped galvanized. All accessories shall be galvanized to ASTM A153 standards. Threads shall be Coarse Thread Series as specified in ANSI B1.1 and may be formed by cutting or rolling.

10.44.00 LUMINAIRES

10.44.01 General

The manufacturer, type, and model of luminaires fixtures shall be supplied as shown on the Plans, Standard Details, or as specified in the Project Special Provisions.

10.44.02 Cobra Head Luminaires

Cobra Head style LED luminaires shall be a power door or drop driver type and be constructed of a single piece die-cast aluminum upper housing and one-piece or two-piece bottom door, hinged at the back, and latched on the street side. The luminaire shall be equipped with an integral slipfitter for 2-inch luminaire arm mounting. The mounting device shall allow the luminaire to be mounted absolutely level and shall have no more than four (4) fasteners serving both the leveling and clamping functions. It shall allow one person to install the luminaire by simultaneously holding it in position and tightening the fasteners, such that the luminaire will be properly level at the first attempt. The luminaire shall be equipped with a 'trigger latch' for easy, one-hand, no-tools opening of the fixture for installation and servicing. A factory installed bird guard shall fit snugly around the mounting device.

The luminaire shall provide a moisture proof and dust proof chamber and weather protection for the ballast. A removable power-pad/module with quick connect electrical hookup for easy installation of the electrical system and easy access to the driver compartment shall be mounted on the door. Top housing mounting or a bridge assembly configuration will not be accepted.

The lens shall be a single piece of optically clear, flat, heat-resistant, impact resistant glass. The sealed optical assembly shall be fully shielded (emitting no direct uplight). The reflector, if used, shall be natural unpainted alzak aluminum and shall be secured to the top housing. The luminaire shall be provided with a photocell receptacle unless otherwise noted on the PLANS. Luminaires shall be pre-wired, requiring only connection of service wires to a terminal board.

10.44.03 Post-Top Luminaire

The post-top luminaire fixture housing shall be as specified by the CITY.

10.44.04 LED Lamps

Luminaires shall be LED type with wattage and lumens rating as specified by the CITY.

10.45.00 CONDUIT

10.45.01 Conduit Type

The location and type of conduit shall be as shown on the PLANS or Standard Details. The CONTRACTOR may furnish and install PVC, or HDPE conduit for the distribution system. Galvanized Rigid Steel (GRS) conduit shall be used where conduit is to be installed externally on a structure. For projects where the surface is largely unpaved, it is the CONTRACTOR's option to furnish and install cable-in-duct, instead of separate conduit and cables for the distribution system.

10.45.02 Polyvinyl Chloride (PVC)

Rigid non-metallic conduit shall be PVC, Schedule 80 and shall conform to NEMA Standard TC-2 and NEMA TC-3. The conduit shall bear an Underwriters' Laboratories (U.L.) label and shall conform to Federal Specification WC-1094A (latest version). The conduit shall be clearly and durably marked at least every 10 feet with the material designation, nominal duct size, and the name and/or trademark of the manufacturer. Fittings for PVC conduit shall be in accordance with U.L. 514. Cement used for the fittings shall be in accordance with the conduit manufacturer's recommendations. Conduit, fittings, and cement shall be supplied by the same manufacturer.

10.45.03 High Density Polyethylene (HDPE)

Flexible non-metallic conduit shall be HDPE. The conduit shall be smooth walled inside and out, and shall be gray in color. The conduit shall be a plastic duct which is intended for underground use, and which can be manufactured and coiled or reeled in continuous transportable lengths and uncoiled for further processing and/or installation without adversely affecting its properties of performance. The conduit shall be manufactured to NEMA Standard TC-7 and ASTM D 3035 SDR11 specifications. The conduit shall be clearly and durably marked at least every 10 feet (10') with the material designation, nominal duct size, and the name and/or trademark of the manufacturer. Fittings for HDPE conduit shall be in accordance with ASTM D 2683. Epoxy used for the fittings shall be in accordance with the conduit manufacturer's recommendations. An approved factory coupling shall be used for connection of the HDPE conduit to a 90° factory PVC elbow or between two lengths of HDPE conduit. The coupling shall be of high density polyethylene material. The coupling shall provide an airtight and watertight lock connection.

10.45.04 Galvanized Rigid Steel (GRS)

Galvanized rigid steel conduit shall be in accordance with ANSI C80.1. GRS conduit shall be galvanized on both the inside and the outside surfaces. The weight (mass) of zinc coating shall be no less than 0.5 ounce per square foot of coated surface, as determined in accordance with AASHTO

T 65. The interior or exterior surface, or both, may be given a coating of suitable material to facilitate installation of wires and cables and to permit the conduit to be readily distinguished from pipe used for purposes other than electrical. All metal conduit ends shall be provided with a bushing to protect the cable from abrasion. Fittings shall be in accordance with ANSI C80.4. A sufficient number of conduit hangers shall be supplied to attach the GRS conduit to the structure, as recommended by the manufacturer. One (1) No. 6 AWG, bare copper ground wire shall be attached to each end of the GRS conduit with a grounding bushing. The ground wire shall be connected to a ground rod at each end of a GRS conduit run or extended to an adjacent GRS conduit or ground rod.

10.45.05 Cable-In-Duct

Cable-In-Duct shall consist of three low voltage, insulated power cables, factory installed in conduit intended for direct burial. The duct shall meet all the specifications for high density polyethylene, as described in Section 10.45.03. The duct shall be clearly and durably marked at least every 10 feet with the material designation, nominal duct size, and the name and/or trademark of the manufacturer. The cables shall meet all the specifications for distribution cable, as described in Section 10.47.00.

10.46.00 PULL AND JUNCTION BOXES

Pull and junction boxes shall be as shown on the PLANS and shall be fiberglass reinforced polymer concrete of a size and shape as indicated on the Standard Details. At a minimum, pull boxes shall be required adjacent to each street light pole and at each power supply. Junction boxes may be either Type 1 or 2, and pull boxes shall be Class 1.

Pull and junction box material is to be an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. Pull boxes shall withstand a wheel load of 22,000 pounds and junction boxes shall withstand a wheel load of 22,000 pounds. All pull and junction boxes are to have an open bottom.

Each pull or junction box shall be equipped with a bolt down cover. The threaded hole that receives the cover lock-down bolt shall be open at the bottom to allow the cleanout of sand, dirt and other debris. Lock-down bolts shall be stainless steel with a hex-head. Pull and junction box covers shall be polymer concrete and shall have a minimum wheel load rating of 22,000 pounds and 22,000 pounds respectively. A lift opening or pull slot shall be provided on all covers. Covers shall be embossed with "STREET LIGHTING".

10.47.00 CABLE

10.47.01 General

The types and lengths of cables shall be supplied as shown on the PLANS, Standard Details, or as specified in the Project Special Provisions. All cable

shall be stranded annealed soft drawn copper wire and shall be the AWG size as listed on the PLANS. Cable shall be 600-volt and be thermoplastic or thermosetting polyethylene insulated. All cable shall be plainly marked on the outside with the manufacturer's name and identification in accordance with industry practice.

10.47.02 Distribution Cable

Distribution cables shall be insulated three-conductor cables (3c), type RHH, RHW-2 or USE-2, meeting the requirements of ICEA S-95-658. Average thickness of insulation shall be no less than 60 mils. The conductors should be no larger than No. 4 AWG and no smaller than No. 8 AWG.

10.47.03 Pole and Bracket Cable

Pole wiring above the handhole, inside the pole to luminaire(s) shall be insulated two-conductor No. 10 AWG cables (2c #10), type THHN/THWN. For poles with dual luminaires, separate cables will be required for each luminaire which will extend up from the break-away fused connectors.

10.48.00 BREAK-AWAY FUSED AND NON-FUSED CONNECTORS

Break-away fused connectors shall be in-line waterproof pre-molded fused slip connector assemblies with rubber insulating boots as shown in the Standard Details. Fused connectors shall be used for each hot cable, and non-fused connectors shall be used for the ground. Connectors shall have one or two copper set screw type terminals to accommodate the wire sizes indicated in the Plans. Fuses shall be high interrupting 8-Amp fuses.

10.49.00 SPLICES

Splices shall be made in junction boxes with copper type K split bolt connectors. All splices shall be protected with a waterproof resin splice kit installed in accordance with the manufacturer's recommendations. Resin splice kits shall consist of a waterproof protective plastic case designed for the split bolt connector, filled with a resin insulating compound mixed in accordance with the manufacturer's recommendations.

10.50.00 POWER SUPPLIES

10.50.01 General

Power supplies shall consist of all equipment and material necessary for the distribution of secondary electrical power as shown on the Plans. Power supplies shall be underground service type, rated for 100 amperes, 240 volts, capable of operating either one, four, or eight-circuits. All power supply assemblies shall be warranted by the manufacturer to be free from defects in workmanship and material for at least one year from the date of project acceptance. Any components found to be defective during the

warranty period shall be replaced free of charge. All warranties provided shall be transferred to the CITY upon project acceptance. Insofar as practical, major items of electrical equipment supplied under a single contract or tied contracts shall be of the same type and consist of products of the same manufacturer to secure uniformity and satisfactory service.

10.50.02 Cabinets

Power supply cabinets shall be of the type and size listed in the PLANS or Standard Details. Cabinets shall be NEMA 3R construction, dust-tight, watertight, corrosion resistant, and constructed of 0.125-inch minimum non-anodized aluminum alloy and be of clean-cut design and appearance. The cabinet shall include individual meter, panel, contactor, and a service pull "compartment". The meter and panel/contactor compartments shall have piano hinged doors. All hinges, catches and other hardware shall be non-ferrous metal or stainless steel.

The meter compartment shall include padlocking provisions, and the panel/contactor outer door shall have a factory installed Corbin lock assembly designed for a standard number 2 key. The panel/contactor compartment shall have an inside panel door. The outer and inside panel doors shall be equipped with an approved doorstop.

Cabinets shall have a control panel constructed of the same material as the cabinet. All equipment such as photoelectric cells, contactors, relays, terminal blocks, circuit breakers, and lightning arrestors shall be installed on the panel as shown on the PLANS. The panelboard shall have silver plated copper buss and shall accept the required number of 1 inch (1") plug-in breakers. Panelboard compartment shall contain photoelectric cell and test switch. All factory installed wire shall be 600 volt rated copper. All terminals shall be approved for copper or aluminum wire. The cabinet shall have a natural aluminum finish.

10.50.03 Photoelectric Cells

Normally a "Control Node" or a "Telecell" equipped with wireless technology for remote control capability shall be required with a 7-pin receptacle for each luminaire fixture. When specifically authorized, photoelectric cells shall be of the solid-state type operating on 120/240 volts and shall operate on a line supply of 60 hertz. The load capacity of the photoelectric cell relays shall be a minimum of 1000 watts.

When a system photoelectric cell is specifically authorized, photoelectric cells shall operate a lighting system through mercury load relays. The photoelectric cell circuitry shall be designed to be normally closed at night. The photoelectric cell shall be configured such that in the event of failure, the lights shall be on. When a system photoelectric cell is specifically authorized, the photoelectric cell shall be mounted inside the power supply cabinet such that all luminaires within the system operate simultaneously and shall illuminate only during hours of darkness or low

visibility. Turn-on shall occur at 2.6 footcandles ± 0.5 footcandles. The photoelectric cell shall have an inverse off/on ratio for energy savings. Photoelectric cells shall sense light levels with a non-drifting phototransistor. The photoelectric cell shall have a time delay to avoid turn off due to lightning and transient light.

A suitable bracket for mounting the photoelectric cell shall be provided. The photoelectric cell shall be mounted into a three-prong twist lock socket, on the side of the cabinet. Test switches used with photoelectric controls shall be three-position switches as shown on the PLANS. Test switches shall be clearly labeled and mounted in the cabinet.

10.50.04 Contactors, Relays, and Terminal Blocks

Contactors, relays, and terminal blocks shall be housed in the cabinet and shall be of the type shown in the Standard Details. The components shall be sized for each lighting circuit as shown on the PLANS. Contactors shall not be electrically or mechanically held, nor shall they include any fusing.

10.50.05 Circuit Breakers

All circuit breakers shall be molded-case thermal-magnetic Type B plug-on circuit breakers. The number and trip rating of circuit breakers shall be as shown on the PLANS. All breakers shall be designed for panel mounting with cable connections on the line and load sides. Type B circuit breakers shall have a minimum of 10,000 amps alternating current interrupting rating at 240 volts alternating current. Type B circuit breakers shall have a nominal size no greater than one inch (1") wide by four inches (4") high by three inches (3") deep. Terminals shall be configured for the wire sizes as shown on the PLANS. If the breaker terminals are not designed for the required wire sizes, suitable terminal adapters, connectors, or terminal blocks shall be used to convert the wire sizes.

10.50.06 Lightning Arrestors

Lightning arrestors shall be rated at 650 volts alternating current.

10.51.00 SPARE EQUIPMENT

If spare equipment is required in the project, such equipment shall conform to these STANDARDS AND SPECIFICATIONS. The items shall be delivered new and undamaged at the place and time specified by the CITY ENGINEER. All existing equipment in excess of the requirements of this project shall be completely removed from the project site by the CONTRACTOR and delivered at the place and time specified by the CITY ENGINEER.

TABLE OF CONTENTS

CHAPTER 11
RECLAIMED WATER SYSTEM

Page

11.00.00 INTRODUCTION 11-1

11.01.00 INTERRUPTION OF SERVICE 11-1
11.02.00 RECLAIMED WATER BREAKS 11-1
11.03.00 METER SET INSTALLATION REINSPECTION FEE 11-1

11.10.00 DESIGN STANDARDS 11-2

11.11.00 SCOPE 11-2
11.12.00 GENERAL 11-2
11.12.01 Reclaimed Water System Utility Study Requirements 11-2
11.13.00 DESIGN DEMAND 11-4
11.14.00 HYDRAULIC DESIGN 11-4
11.15.00 OPERATING PRESSURES WITHIN THE DISTRIBUTION SYSTEM 11-4
11.16.00 PRESSURE REGULATING STATIONS 11-4
11.17.00 SIZING OF MAINS 11-5
11.17.01 Distribution Mains 11-5
11.17.02 Transmission Mains 11-5
11.18.00 SYSTEM LAYOUT - CONSTRUCTION PLAN STANDARDS 11-5
11.18.01 General 11-5
11.18.02 Reclaimed Waterline Crossing Over A Sanitary Sewer Line 11-6
11.18.03 Reclaimed Waterline Crossing Over A Storm Sewer Line 11-7
11.18.04 Reclaimed Waterline Crossing Over A Potable Water Line 11-7
11.18.05 Sanitary Sewer Line Crossing Over A Reclaimed Waterline 11-7
11.18.06 Storm Sewer Line Crossing Over A Reclaimed Waterline 11-8
11.18.07 Potable Waterline Crossing Over A Reclaimed Waterline 11-8
11.18.08 Limits On Vertical Separation 11-8
11.18.09 Combination Air Valves 11-8
11.19.00 EASEMENTS 11-9
11.20.00 FUTURE CONNECTIONS 11-9
11.21.00 SERVICES 11-10
11.22.00 TRANSMISSION MAINS 11-11
11.23.00 UNLAWFUL CONNECTION 11-11
11.24.00 APPURTENANCES 11-12
11.24.01 Valves 11-12
11.24.02 Fire Hydrants 11-12
11.24.03 Thrust Blocks and Joint Restraint Devices 11-12
11.24.04 Meters 11-13
11.24.05 Fire Protection Service Line 11-13
11.24.06 Valve Vaults 11-13
11.24.07 Manholes 11-13
11.24.08 Backflow Prevention Assemblies 11-13

11.30.00 CONSTRUCTION SPECIFICATIONS 11-14

11.31.00 TRENCHING, BACKFILLING AND COMPACTION 11-14
11.32.00 BEDDING 11-14
11.33.00 PIPELINE INSTALLATION 11-14

11.33.01 General *11-14*
11.33.02 Pipe *11-15*
11.33.03 Fittings *11-16*
11.34.00 VALVE AND VALVE BOX INSTALLATIONS 11-17
11.35.00 THRUST BLOCKS 11-17
11.36.00 CONNECTION TO EXISTING MAINS 11-18
11.37.00 FIRE HYDRANT INSTALLATION 11-18
11.38.00 TAPS 11-18
11.39.00 METER INSTALLATION 11-19
11.39.01 3/4-Inch and 1-Inch Meter Installations *11-20*
11.39.02 1-1/2-Inch and 2-Inch Meter Installations *11-20*
11.39.03 3-Inch and Larger Meter Installations *11-20*
11.40.00 TESTS 11-21
11.40.01 General *11-21*
11.40.02 Filling and Venting Lines *11-21*
11.40.03 Disinfection *11-22*
11.40.04 Flushing the Main *11-22*
11.40.05 Pressure Test *11-22*
11.40.06 Bacteriological and Turbidity Test *11-23*
11.40.07 Cathodic Protection System Testing *11-23*
11.40.08 Cross Connection Test *11-24*

11.50.00 MATERIALS 11-25

11.51.00 GENERAL 11-25
11.52.00 PIPE 11-25
11.52.01 Ductile Iron Pipe (DIP) *11-25*
11.52.02 Polyvinyl Chloride Pipe (PVC) *11-26*
11.52.03 Steel Pipe *11-27*
11.53.00 FITTINGS 11-27
11.54.00 VALVES 11-28
11.54.01 General *11-28*
11.54.02 Gate Valves *11-28*
11.54.03 Butterfly Valves *11-29*
11.54.04 Valve Boxes *11-30*
11.55.00 FIRE HYDRANTS 11-30
11.56.00 BLOW-OFFS 11-30
11.57.00 MANHOLES AND VAULTS 11-30
11.57.01 General *11-30*
11.57.02 Rings and Covers *11-31*
11.57.03 Base Slabs and Base Beams *11-32*
11.57.04 Joint Material *11-32*
11.57.05 Mortar *11-32*
11.58.00 VAULT ELECTRICAL AND MECHANICAL 11-32
11.59.00 VENT PIPES 11-32
11.60.00 SERVICE CONNECTIONS 11-33
11.60.01 Pipe *11-33*
11.60.02 Saddles *11-33*
11.60.03 Curb Stop Valves and Curb Stop Boxes *11-33*
11.60.04 Tapping Sleeve and Valve *11-34*
11.60.05 Corporation Stops *11-34*
11.60.06 Stop and Waste *11-34*
11.60.07 Compression Couplings *11-34*

11.61.00 ENCASEMENT 11-36
11.61.01 Concrete *11-36*
11.61.02 Polyethylene Encasement *11-36*
11.61.03 Extruded Polystyrene Insulating Foam *11-36*
11.62.00 METERS 11-37
11.62.01 General *11-37*
11.62.02 Magnetic Drive Positive Displacement-Type Reclaimed Water Meters *11-37*
11.62.03 Turbine Meters *11-37*
11.62.04 Mastered Meters *11-37*
11.62.05 Metered Bypass Line *11-37*
11.62.06 Meter Check Valves *11-37*
11.62.07 Meter Valves *11-38*
11.62.08 Meter Yokes (Setters) *11-38*
11.62.09 Valve and Meter Supports *11-39*
11.62.10 Meter Pits (3/4" and 1" service lines) *11-39*
11.63.00 PRESSURE-REDUCING VALVE 11-39
11.64.00 COMBINATION AIR VALVES 11-39
11.65.00 RESTRAINING SYSTEMS 11-40
11.65.01 Harness Rods *11-40*
11.65.02 Joint Restraint Devices *11-40*
11.66.00 CONCRETE REINFORCEMENT 11-41
11.67.00 BACKFLOW PREVENTION ASSEMBLIES 11-41
11.68.00 REPAIR CLAMPS 11-41

CHAPTER 11
RECLAIMED WATER SYSTEM

11.00.00 INTRODUCTION

All reclaimed water distribution systems constructed within the CITY of Westminster shall comply with the requirements of these STANDARDS AND SPECIFICATIONS and may include additional special standards established by the CITY for overall hydraulics of the reclaimed water utility system. Special standards shall be outlined at pre-design meetings, as determined necessary by the CITY ENGINEER.

In the case of reclaimed water mains larger than 12 inches, the owner or his representative shall submit construction specifications and drawings to the CITY for review and approval prior to the CITY's approval of the PLANS.

All references to standards and manuals shall refer to the most current edition unless noted otherwise.

11.01.00 INTERRUPTION OF SERVICE

The CITY's Utilities Operations Division will operate all existing valves, blow-offs and curb stops. **No valve or other control device on the existing public system will be operated for any purpose by anyone other than the Public Works & Utilities Department.** Twenty-four hours prior to the interruption of service, the CONTRACTOR shall notify all users whose the CITY's Public Works Utilities Operations Division and affected customers. No interruptions may last longer than three days without prior written approval from the CITY ENGINEER.

In certain situations to lessen the impacts to adjacent customers (e.g. residences, businesses, schools, etc.), the WORK detailed in this section may require night or weekend construction at the direction of the CITY ENGINEER.

11.02.00 RECLAIMED WATER BREAKS

If notification prior to shutdown is impossible, the CONTRACTOR shall notify the CITY's PWU Operation Division and affected customers within one hour after the shutdown.

11.03.00 METER SET INSTALLATION REINSPECTION FEE

Water tap fees provide for the initial inspection of the meter set only. Where additional inspections are made necessary by incomplete or faulty work, a fee in accordance with CITY CODE will be charged for the second inspection and each subsequent inspection. This fee shall be charged to the holder of the permit and paid to the CITY before any additional inspections will be made.

To schedule an inspection during regular business hours, contact the Utility Operations Division Meter Shop at 303 658-2549. For after hours emergencies call Police dispatch at 303 658-4360.11.10.00

DESIGN STANDARDS

11.11.00 SCOPE

It is the intent of this "design standards" section to provide sufficient detailed information to enable the Engineer for the Owner/Developer to correctly and efficiently design the overall reclaimed water system for a particular development. If there is a question or a concern regarding the design of any portion of the reclaimed water system that is not adequately answered within this chapter, the owner/developer or his representative shall contact the CITY to get all issues resolved prior to design. Any deviation from these STANDARDS AND SPECIFICATIONS must be approved in writing by the CITY ENGINEER.

11.12.00 GENERAL

The reclaimed water system shall be designed by or under the direct supervision of a Professional Engineer registered in the State of Colorado utilizing the most current technical standards along with good, sound engineering judgment throughout the design process. The engineer shall have experience in the design and construction of municipal reclaimed water distribution systems. The development approval process includes the submittal of a Preliminary Development Plan, an Official Development Plan, utility study and construction drawings for review and approval by the CITY ENGINEER. The reclaimed water system designs shall be reviewed by the Reclaimed System Analyst and Utilities Engineering Group in the Public Works Department prior to final approval.

The reclaimed water system utility studies may be combined with the potable water and sanitary sewer utility studies.

11.12.01 Reclaimed Water System Utility Study Requirements

The Utility Study shall include the following information and shall be bound in an 8 ½ x 11 inch folder:

1. **Certification statement** - shall be included at the beginning of the report and shall read as follows: “This Utility Report for the design of the _____ development was prepared by me or under my direct supervision in accordance with the City of Westminster’s Standards and Specifications and acceptable professional practices of the industry. We acknowledge that the City of Westminster’s review of this Utility Study is only for general conformance with submittal requirements, current design standards and standard engineering principles and practices. We are also aware of the provisions of Section 11-6-5(B) of the Westminster Municipal Code.” The seal and signature

of the Professional Engineer responsible for preparing the report shall follow this statement.

2. **Report text** for the water system design shall include the following at a minimum:
    a. **Project location and Description** – a description of the boundary streets, project area and type of development proposed or anticipated use. Include a vicinity map.
    b. **System layout** – a description of the existing and proposed reclaimed water infrastructure in conformance with the CITY's latest master plan shall be provided and reference shall be made to a figure in the back of the report illustrating these improvements. The description shall include the sizes and types of existing and proposed pipes and the influence of the improvements on the project and surrounding area.
    c. **Design flow requirements** - Complete design flow calculations and a discussion explaining the calculations and assumptions shall be provided.
    d. **Hydraulic Analysis -** Hydraulic analysis may be required. Contact the Reclaimed System Analyst in Public Works to determine the need and parameters for hydraulic analysis. If modeling is required, minimum and maximum flow conditions will need to be modeled. Model results shall be presented in a table format. A figure indicating pipe and junction labels shall be provided.
    e. **Conclusions** – a description of the results and how they follow the CITY standards shall be provided. Any deviations from the CITY standards shall be described and applicable variances requested.
    f. **Appendices** - Printed data output from the modeling results shall be provided in the appendix and shall correspond with a figure of the pipe and node network. The appendix shall also include flow test results, hand calculations and any other pertinent data. A large size figure (11" x 17" or larger) illustrating the existing and proposed utility improvements shall be provided and shall conform to the CITY's latest reclaimed water master plan. The drawing shall include pressure zone boundaries, elevation contours and locations of proposed and existing utility easements and right-of-way.

In situations where a previous utility study was conducted and is still applicable, a utility conformance letter may be submitted in place of the Utility Study, at the discretion and with written authorization of the CITY ENGINEER.

11.13.0 DESIGN DEMAND

The irrigation demands for a particular development vary depending on the type of landscape. The peak irrigation demand shall be determined by the irrigation designer. Peak week, peak day, and peak hour shall be estimated and provided to the CITY ENGINEER.

The CITY ENGINEER shall be consulted for design standards with regard to non-standard developments, design of municipal infrastructure such as transmission mains, pump stations, etc. and for development with unusually high demands. The CITY ENGINEER shall have final input in these instances.

11.14.0 HYDRAULIC DESIGN

The CITY ENGINEER shall be contacted to determine if a model is required. If required, a computer generated hydraulic analysis of the proposed infrastructure, or "model," shall be developed using industry standard software such as WaterCAD or CITY approved equal. The model shall be based on the CITY's latest Reclaimed Water Master Plan. Contact the Reclaimed Water Analyst in the Public Works department for design standards and Master Plan information. Transmission mains and laterals may be oversized for future buildout, see Section 11.17.02. These guidelines are a baseline, and the CITY ENGINEER reserves the right to review and approve designs.

For purposes of hydraulic modeling, Hazen Williams C coefficient shall be 130 for PVC pipe, lined ductile iron pipe, and lined steel pipe. For any other condition, coordination with the PWU Department is required.

11.15.00 OPERATING PRESSURES WITHIN THE DISTRIBUTION SYSTEM

For specific design pressures associated with the reclaimed water system, the Reclaimed Water Analyst must be contacted prior to beginning system design efforts.

11.16.00 PRESSURE REGULATING STATIONS

Pressure reducing valve (PRV) installations should be avoided. In areas where a main extension may cause pressures to be greater than the existing zone pressure, the DEVELOPER must discuss alternatives with PWU. Detailed design of any PRV installations shall be performed by the developer's engineer with input from Public Works.

For individual reclaimed water service lines, water pressure regulators will be required if system pressures exceed 80 psi or at the discretion of the CITY ENGINEER.

11.17.00 SIZING OF MAINS

11.17.01 Distribution Mains

All reclaimed water mains shall be sized large enough to provide for irrigation flows to the area serviced. The maximum pipe veloCITY shall be 7 feet per second. Final size of distribution mains shall be in accordance with the CITY's most recent reclaimed water system master plan, and approved in writing by the CITY. In some circumstances, the reclaimed water system would be extended to service a new development, but would not yet be constructed to full build-out as shown in the master plan. If in this case, the pipe size needed for the development is smaller than the pipe size shown in the master plan, the CITY will pay for the cost differential of the pipe, subject to the CITY ENGINEER's written approval.

11.17.02 Transmission Mains

All transmission mains shall be sized in order to meet the demand at peak irrigation, as sized in the CITY's latest reclaimed water system master plan, or as otherwise approved in writing by the CITY. See section 11.22.00 for further details. In some circumstances, the reclaimed water system would be extended to service a new development, but would not yet be constructed to full build-out as shown in the master plan. If in this case, the pipe size needed for the development is smaller than the pipe size shown in the master plan, the CITY will pay for the cost differential of the pipe, subject to the CITY ENGINEER's written approval.

11.18.00 SYSTEM LAYOUT – CONSTRUCTION PLAN STANDARDS

11.18.01 General

All reclaimed water mains shall be installed in dedicated RIGHT-OF-WAY or public easements. Reclaimed waterlines should NOT be installed parallel to and directly below any concrete such as sidewalks, curbs, or gutters. Location of lines within the street shall be as directed by the CITY ENGINEER.

The minimum depth of cover for reclaimed water mains from the final approved grade of the surface to the top of the reclaimed water main shall be 5 feet. Where final grades have not been established, mains shall be installed to a depth great enough to insure 5 feet of cover below the approved future grade but in no event less than 5 feet of cover from the temporary grade. The maximum depth of cover for reclaimed water mains shall be 8 feet below the final approved grade of the surface unless approved otherwise, in writing, by the CITY ENGINEER.

Plan and profile shall be required for all reclaimed water main designs. Utility crossings shall be identified in the profile views for all known or planned utilities. The vertical alignment of reclaimed water mains shall be designed

such that unnecessary high points are avoided. If a high point in the main cannot be avoided, a controlled high point shall be located at a fire hydrant tee where trapped air in the system can be bled. High points at a reclaimed water main lowering should be avoided by deflecting the main on both sides of the lowering such that positive pipe grades are maintained to controlled high points in the system. To maintain positive pipe grades to controlled high points, the maximum depth of cover to the main can increase to 8 feet, if approved in writing by the CITY. Refer to Sections 3.18.02 and 3.18.06 for the alignment of water lines with sewer lines. Refer to Section 3.18.07 for the design of combination air valves.

Reclaimed water mains shall be laid a minimum of ten feet, horizontally and edge to edge, from any existing or proposed utility. Upon written approval by the CITY, a water main may be laid closer than ten feet to a parallel sewer main if it is laid in a separate trench and if the elevation of the invert of the reclaimed water main is at least 18 inches above the crown of the sewer main and, in addition, PVC C-900 is used for the sewer main.

Reclaimed water mains shall be designed such that they extend the entire frontage of the property to be served or as otherwise approved in writing by the CITY.

In all cases, valves shall be located on either side of such crossings so that the reclaimed water main can be completely isolated for convenience in maintenance and repair.

The Standard Reclaimed Water Notes found on the CITY website shall be included on all reclaimed water construction plans and documents.

11.18.02 Reclaimed Waterline Crossing Over A Sanitary Sewer Line

Reclaimed waterline crossings over sanitary sewer lines shall be evaluated with the same standards as potable waterline crossings over sanitary sewer lines. When there is less than 18 inches of vertical clearance between the water main and the sanitary sewer pipe, or water main pipe joints extend less than 10 feet each side of the sewer pipe, one of the following secondary containments shall be required for the water or sewer pipe:

1) Utilize Pressure Pipe AWWA C900 for the sanitary line.

2) Utilize concrete or flowable fill encasement, extending to any joints within 10 feet of the crossing.

If joint-less pipe, such as fusible PVC or welded steel, is used for the water or sanitary sewer pipe then secondary containment will not be required. However, structural support of the water or sewer main using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

Minimum criteria is presented in this section, and applies to both public mains and private service lines.

11.18.03 Reclaimed Waterline Crossing Over A Storm Sewer Line

Reclaimed waterline crossings over storm sewer lines shall be evaluated with the same standards as potable waterline crossings over storm sewer lines. When there is less than 18 inches of vertical clearance between the reclaimed water main and the storm sewer. Freeze potential of a reclaimed water main shall be evaluated when crossing storm sewers or other exposures to the elements. If a water main crosses a storm sewer with 3 feet or less of vertical clearance, a 12" thick layer of extruded polystyrene insulating foam, also referred to as "XPS" shall be provided all around the water main for a minimum of 5 feet on each side of the storm sewer. The sheets of "XPS" shall be thick enough to allow shaping of the material so it fits snugly around all sides of the pipe leaving a minimum 12" thickness around all sides of the pipe. Bonding of individual sheets of "XPS" shall be in accordance with Chapter 3 of these STANDARDS AND SPECFICIATIONS. Crossings of dead end reclaimed water mains and storm sewer with less than 18 inches of vertical clearance shall be prohibited.

11.18.04 Reclaimed Waterline Crossing Over a Potable Water Line

In all cases, regardless of vertical clearance, the reclaimed water line shall be encased in concrete a minimum of nine feet on each side of the centerline of the crossing or PVC pressure pipe in accordance with AWWA C900, pressure class 305 psi may be used for the reclaimed water line.

11.18.05 Sanitary Sewer Line Crossing Over a Reclaimed Waterline

Sanitary sewer line crossings over reclaimed waterlines shall be evaluated with the same standards as sanitary sewer line crossings over potable waterlines. When there is less than 18 inches of vertical clearance between the water main and the sanitary sewer pipe, or water main pipe joints extend less than 10 feet each side of the sewer pipe, one of the following secondary containments shall be required for the water or sewer pipe:

1) Utilize Pressure Pipe AWWA C900 for the sanitary line.

2) Utilize concrete or flowable fill encasement, extending to any joints within 10 feet of the crossing.

Note that if joint-less pipe, such as fusible PVC or welded steel, is used for the water or sanitary sewer pipe then secondary containment will not be required. However, structural support of the water or sewer main using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

Minimum criteria is presented in this section, and applies to both public mains and private service lines.

11.18.06 Storm Sewer Line Crossing Over a Reclaimed Waterline

Storm sewer line crossings over reclaimed waterlines shall be evaluated with the same standards as storm sewer line crossings over potable waterlines. In all cases, regardless of vertical clearance, the joints of the storm sewer shall be encased in concrete a minimum of nine feet on each side of the centerline of the crossing.

Freeze potential of a reclaimed water main shall be evaluated when crossing storm sewers or other exposures to the elements. If a water main crosses a storm sewer with 3 feet or less of vertical clearance, a 12" thick layer of extruded polystyrene insulating foam, also referred to as "XPS" shall be provided all around the water main for a minimum of 5 feet on each side of the storm sewer. The sheets of "XPS" shall be thick enough to allow shaping of the material so it fits snugly around all sides of the pipe leaving a minimum 12" thickness around all sides of the pipe. Bonding of individual sheets of "XPS" shall be in accordance with Chapter 3 of these STANDARDS AND SPECIFICATIONS. Crossings of dead end reclaimed water mains and storm sewer with less than 18 inches of vertical clearance shall be prohibited.

11.18.07 Potable Waterline Crossing Over a Reclaimed Waterline

When there is less than 18 inches of vertical clearance between the potable water line and the reclaimed water line, the reclaimed water line shall be encased in concrete a minimum of nine feet on each side of the centerline of the crossing or PVC pressure pipe in accordance with AWWA C900, pressure class 305 psi may be used for the reclaimed water line.

11.18.08 Limits On Vertical Separation

Under no circumstances shall the vertical clearance between any reclaimed water, potable water, sanitary sewer, or storm sewer pipe be less than 18 inches without written approval from the CITY ENGINEER.

11.18.09 Combination Air Valves

Combination air valves are necessary to serve several functions: they exhaust large volumes of air from the system during start-up, they open during draining or if a negative pressure occurs and they release accumulated air from the system during operation. At depressions of the reclaimed water system, a combination air valve is required on each side of the depression for this reason. The vertical alignment of Reclaimed Water mains shall be designed such that unnecessary high points are avoided as described in Chapter 3 of these STANDARDS AND SPECIFICATIONS. If a high point in a

reclaimed water main cannot be avoided, an air valve shall be located at the high point and within a manhole.

Combination air valves for distribution mains and transmission mains shall be sized by the DEVELOPER in accordance with the manufacturer's recommendations and approved by the CITY ENGINEER.

11.19.00 EASEMENTS

All reclaimed water mains shall be in an easement which has a horizontal width of at least two times the depth to the pipe invert. The minimum easement shall be 20 feet in width for one utility, 30 feet in width for two utilities, and 40 feet in width for three utilities. Site-specific circumstances may dictate the need for wider easements. For normal depths, the main shall be located a minimum of 10 feet from and parallel to the edge of the easement. Meters not installed within the RIGHT-OF-WAY will require an easement dedication ten feet wide and extending five feet behind the meter. If water meter extends behind the curb more than ten feet, then the width of the easement shall be a minimum of 15 feet. All easements shall be for the exclusive use of the CITY. Neither landscaping (except grass and private irrigation systems) nor permanent structures (sheds, buildings, etc.) shall be placed in the easement.

The easement agreement, provided by the CITY, shall state that any temporary structures (including paving and fencing) placed in the easement shall be removed and replaced by the OWNER when requested by the CITY so that maintenance can be performed. The OWNER shall agree to hold the CITY harmless for any replacement of structures removed from the easement.

The following statement shall appear on all Official Development Plans and all final plats**.**

UTILITY MAINTENANCE STATEMENT

All public water, reclaimed water, storm sewer and sanitary sewer mains and appurtenances located in public RIGHT-OF-WAY shall be maintained by the CITY PWU Department. All public water, reclaimed water, storm sewer, sanitary sewer mains and appurtenances under private drives are located in utility easements. CITY is responsible for maintenance of these water, reclaimed water, storm and sanitary sewer facilities. CITY is not responsible for repair or replacement of private drive, curb and gutter or landscaping damaged during utility repair or maintenance.

11.20.00 FUTURE CONNECTIONS

A blow-off shall not be installed at the end of any reclaimed water main which terminates and is anticipated to be extended in the future, except at the direction of the CITY ENGINEER. When a future main extension is anticipated, the main shall include valves so that only one valve will have to be closed when the main is extended. The valve shall be restrained so when the one valve is closed and the line to be extended is exposed, the valve will not blow off. Restraint shall be made by the

use of a mechanical joint anchoring tee (swivel tee), swivel cross, and by installing a minimum of two full lengths of pipe on the extension side of the valve (8 inch pipe and smaller). No service taps shall be allowed on a main which can be extended in the future between the single valve to be closed and the dead end.

11.21.00 SERVICES

Calculations for meter and service line sizes shall be prepared using information from the CITY PWU Department Water Resources Analyst and Reclaimed Water Analyst. The calculations will be based on the irrigated area, type of turf, number of zones, water requirements and restrictions, and other pertinent information in accordance with Section 8-12-5(A) of the CITY CODE. The applicant shall prepare plans and calculations and submit them to the Reclaimed Water Analyst for review and approval. The Water Resources Analyst and Reclaimed Water Analyst must approve all meter and service line sizes (before and after the meter) prior to beginning construction. The service lines, tap and meter shall be the same size, unless otherwise approved and/or required by the CITY ENGINEER. If the tap and meter are of different sizes, the fee shall be paid based on the larger size, unless a larger tap is approved and/or required by the CITY ENGINEER in which case the fee for the meter size shall be paid. Refer to the Reclaimed System Analyst, PWU, with any questions.

Each development with areas serviced with reclaimed water is required to have a separate reclaimed water tap and meter from the reclaimed water main, in accordance with Section 8-12-6(A) of the CITY CODE. Each owner shall have a separate meter, unless a business association is formed. In that instance, the association would be the owner of the meter. The business association must be finalized before the Notice of Authorization (NOA) can be issued.

Utility easements shall be required for service lines up to and including the meter pit.

No pressure booster facility of any kind shall be allowed on any service line between the public main and the meter. All service line pressure booster facilities shall be privately owned and maintained.

Reclaimed water service lines shall be located a minimum of 10 feet away from all other services, unless an exception is approved by the CITY. All service lines shall be constructed perpendicular to the front property line of the property to be served and not less than 5 feet from the side of a front property line. New service lines through private property to serve a separate property are prohibited.

Size changes, if allowed between the service line and the meter, shall be accomplished by providing a full sized meter vault and setter for the line size installed and using industry standard adapters to install a reduced size meter in the full size line.

Reclaimed water taps cannot be issued prior to a NOA issue by the State of Colorado.

11.22.00 TRANSMISSION MAINS

All water mains larger than 12 inch in diameter shall be classified as "transmission mains."

All transmission mains shall have combination air valves installed at all high points on the line and on each side of butterfly valves in accordance with the Standard Details in the Appendix of this Chapter.

Only purple PVC pipe is approved for reclaimed water main installations 12 inches in diameter and smaller. Lines 20 inches in diameter and larger may be purple colored ductile iron pipe or steel pipe, as approved in writing by the CITY ENGINEER. A Hazen Williams C coefficient of 130 shall be used when modeling PVC and DIP pipe and shall be 100 for steel pipe, unless otherwise approved in writing by the CITY.

The design of ductile iron and steel transmission mains and other critical direct bury appurtenances such as valves, shall require cathodic protection. Cathodic protection shall be designed by a qualified Cathodic Protection Engineer, registered in the State of Colorado and shall conform to NACE Standard RP-01-69, latest revision. As a minimum, the cathodic protection system shall include magnesium anodes; test station thermal board and shunts; exothermic weld caps and coating; conductor, test stations, joint bond wires; wire splice kits; exothermic weld equipment and materials; wire and cable marker tags; and one-piece insulating sleeves and washers, all in conformance with these STANDARDS AND SPECIFICATIONS. All of the data for these materials shall be submitted to the CITY for approval prior to installation. Test stations shall be shown on design drawings and as-built drawings. Cathodically protected pipe, except steel casing pipe, shall also require polyethylene wrap as described in these STANDARDS AND SPECIFICATIONS.

No service line taps or any taps less than six inches in diameter shall be made to transmission mains. Exceptions to this will be for combination air valves only.

Valves of transmission mains shall be placed no more than 800 feet apart, unless an exception is approved in writing by the CITY ENGINEER. Where there are connections to transmission mains, all connecting mains shall include valves at the connection. There shall be a minimum of two valves at a tee connection and three valves at a cross connection.

11.23.0 UNLAWFUL CONNECTION

No installation of reclaimed water supply piping or part thereof shall be made in such a manner that it will be possible for used, unclean, polluted, or contaminated water, mixtures, or substances to enter any portion of such piping from any tank, receptacle, equipment, or plumbing fixture by reason of back siphonage, suction, back pressure, or any other cause, either during normal use and operation or when any such tank receptacle, equipment, or plumbing fixture is flooded, or subject to pressure in excess of the main line operating pressure. No person shall make a connection or allow one to exist between pipes or conduits carrying domestic water supplied by the CITY and any pipes, conduits, or fixtures containing or

carrying water, chemicals, liquids, gases, or any other substances from any other source. Refer to Chapter 3 of these STANDARDS AND SPECIFICATIONS, Backflow Prevention Assemblies for further requirements.

The purpose of **purple** pipe, detectable tape, and polyethylene encasement (poly wrap) material for reclaimed water systems is to assist in prevention of cross connections between potable and reclaimed water systems. The color purple is required by CITY CODE and is required for compliance with State of Colorado Regulation 84.

11.24.00 APPURTENANCES

11.24.01 Valves

Valve placement shall be such that there are at least two valves at every tee and three valves at every cross. Valves 16 inch or larger shall be butterfly valves. Main line valves shall be located at a tee, cross or elbow if possible. Under no circumstances shall a valve be located in concrete areas, such as sidewalks, crosspans, aprons, curbs, or gutters. Butterfly valve operators shall be located on the north or east side of the water main. Any valve located in a greenbelt area shall have an 18-inch-wide by 6-inch thick concrete collar around the valve box. All 16" and larger butterfly valves will be accessible in a vault.

11.24.02 Fire Hydrants

No fire hydrants are allowed on the reclaimed water system.

11.24.03 Thrust Blocks and Joint Restraint Devices

All bends, tees, plugs, dead-ends, wet taps (in certain cases), hydrants, and blow-offs shall be designed and constructed with concrete thrust blocks. If the soil-bearing strength is unknown, the soil-bearing capacity used in design shall be 2,000 pounds/square foot. Refer to the detail drawings in the Appendix of this chapter.

Joint restraint devices shall be used on both sides of valves and fittings for pipe sizes 12 inches in diameter and smaller and in addition to thrust blocks. Vertical bends in all pipe sizes shall be restrained using joint restraint devices and shall be restrained for a specified distance as recommended using the latest edition of AWWA Manual M23 and M41, as appropriate.

Harness rods, or "rodding", are not an acceptable means for restraining pipe and fittings unless it is specified inside vaults as shown on the detail drawings in the appendix of this Chapter. Under no circumstance shall steel harness rods be allowed to be in contact with soils.

11.24.04 Meters

Calculations for meter and service line sizes (before and after the meter) shall be prepared using the sizing information available from the CITY PWU Water Resources Analyst. The applicant shall prepare plans and reclaimed water demand calculations and submit them to the CITY Water Resources Analyst for review and approval. The CITY Water Resources Analyst must approve all meter and service line sizes prior to beginning construction. The service lines, tap and meter shall be the same size, unless otherwise approved and/or required by the CITY ENGINEER. If the tap and meter are of different sizes, the fee shall be paid for the larger, unless a larger tap is approved and/or required by the CITY ENGINEER in which case the fee for the meter size shall be paid.

Inspections of all meter pits or vaults shall be conducted by the CITY ENGINEER. Locations and details for pits or vaults shall be reviewed and approved in writing by the CITY ENGINEER.

11.24.05 Fire Protection Service Line

No fire protection service lines are allowed on the reclaimed water system.

11.24.06 Valve Vaults

All valves larger than 12 inches shall be installed in a vault in accordance with the Standard Details in the Appendix of this Chapter. All valve vaults shall be capable of withstanding AASHTO H-20 highway loading. The vault shall also have lift hooks in the roof for valve removal inside the vault.

Vaults shall be made water proof after construction by use of sealants, epoxies or other approved methods. All vaults shall be designed with wall sleeves and link seal and be capable of handling thrusts caused by removing valves. All vent pipes for vaults shall be installed in conformance with the Standard Details in the Appendix of this Chapter.

11.24.07 Manholes

Manholes shall be installed on all pressure regulating valves, all butterfly valves, permanent blow-off installations, and air release valves in accordance with the Standard details in the Appendix of this Chapter.

11.24.08 Backflow Prevention Assemblies

To prevent backflow contamination of the CITY potable water system, a reduced pressure zone backflow prevention device shall be used for all non-residential irrigation services. This shall be required for both domestic and reclaimed water sources. The assembly shall be located a minimum of five feet downstream of the water meter and installed per CDPHE guidelines and Section 8-7-27 of the CITY CODE to allow for proper operation and easy access for annual testing and maintenance.

11.30.00 CONSTRUCTION SPECIFICATIONS

11.31.00 TRENCHING, BACKFILLING AND COMPACTION

Trenching, backfilling and compaction shall be done in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

11.32.00 BEDDING

In the event unstable trench conditions are found at pipeline grade, a minimum of one and one-half inch uniformly graded, washed rock shall be used for trench stabilization. Depth of the stabilization shall be as approved in writing by the CITY ENGINEER.

Granular bedding material shall meet the requirements of Chapter 9 of these STANDARDS AND SPECIFICATIONS. Bedding shall be placed to six inches below the bottom of the pipe and shall be placed around the sides of the pipe and to a minimum of 12 inches above the top of the pipe and in accordance with the Standard Details the Appendix of this Chapter.

11.33.00 PIPELINE INSTALLATION

11.33.1 General

The CITY shall be notified at least 48 hours in advance of any pipe installation. No pipes shall be backfilled until they have been inspected by the CITY. Alignment and grade of the pipe and the location of fittings, valves, and hydrants shall be staked in accordance with the approved construction plans under the supervision of a Professional Land Surveyor registered in the State of Colorado.

Proper implements, tools, and facilities shall be provided and used by the CONTRACTOR for the safe and convenient execution of the work. All pipe fittings, valves, and hydrants shall be carefully lowered into the trench by means of a derrick, ropes, or other suitable tools or equipment to prevent damage to water main materials and protective coatings and linings. Chains or cables shall not be used for handling pipe with protective coatings. Under no circumstances shall water main materials be dropped or dumped into the trench.

All pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. The groove in the bells of the pipe shall be full and continuous or the pipe will be rejected. Defective pipe or fittings shall be removed from the job site within 24 hours of notification by the CITY ENGINEER. All foreign matter or dirt shall be removed from the interior and ends of pipe and accessories before they are lowered into position in the trench and prior to connection.

Every precaution shall be taken to prevent foreign material and trench water from entering the pipe and fittings. During construction, the CONTRACTOR

shall provide and maintain adequate equipment to properly remove and dispose of all water entering the trench and any other part of the work.

11.33.02 Pipe

Immediately before joining two lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned. Caution shall be exercised to ensure that the correct type of gasket is used. A thin film of gasket lubricant shall be applied to the inside face of the gasket and the spigot end of the pipe. The spigot end of the pipe shall be placed in the bell with care to prevent the joint from contacting the ground. The joint shall be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements. Pipe furnished without a depth mark shall be marked before assembly to ensure insertion to the full depth of the joint. The pipe shall then be properly set and brought to correct line and grade. After installation of the polyethylene protective wrap, if required, the pipe shall be secured in place by installation of bedding material and backfill, in accordance with Chapter 9 and the detailed drawings in the Appendix of this chapter. All pipe laying shall be in accordance with AWWA C600 and AWWA C605.

Deflection from a straight line or grade, as required by horizontal or vertical alignments or offsets, shall not exceed fifty percent (50%) of the maximum allowable limits set by the manufacturer's specifications. If the alignment requires deflection in excess of the allowable deflection per joint, special bends, or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limits set forth, as approved, in writing, by the CITY ENGINEER.

All fittings, appurtenances and ductile iron pipe shall be protected with minimum 8 mil polyethylene film wrap in accordance with these STANDARDS AND SPECIFICATIONS. Additionally, approved wax taping and zinc caps shall be placed on all bolted fittings. Miscellaneous steel or other ferrous pipe for temporary blow-offs, etc., shall be similarly protected. Methods for applying the wrap shall conform to the Standard Details in the Appendix of this Chapter.

At times when installation is not in progress, the open ends of the pipe shall be closed with a watertight plug. Pipe should be kept clean, dry, and supported off the surface of the ground. 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 lining, leaving a smooth end at right angles to the axis of the pipe. Pipe ends shall be smooth and beveled with a file or other tools according to the pipe manufacturer's recommendations.

Extra care should be used in handling PVC pipe during cold weather due to the reduced flexibility and impact resistance as temperatures approach and drop below freezing. PVC pipe to be stored outside and exposed to sunlight for more than 30 days shall be covered with an opaque material such as

canvas. Clear plastic sheets shall not be used to cover the pipe. Air circulation shall be provided under the covering. Any over-exposed pipe, as determined by the CITY ENGINEER, will not be permitted for installation.

All PVC waterline installations shall include the installation of a single, 12-gauge, insulated copper tracing wire taped to the top of the pipe. The tracing wire shall be installed in a continuous run between manholes and meters, and the ends of the tracer wire shall be brought to the surface in a cathodic protection box in accordance with the detail drawing in the Appendix of this chapter. Wire splices shall be accomplished in accordance with the detail in the Appendix of this chapter. Tracer wire shall be tested by the CITY ENGINEER, or by the CONTRACTOR and observed by the CITY ENGINEER, for continuity prior to acceptance.

During the backfilling of all PVC reclaimed waterline trenches, a continuous 2-inch-wide metallic-coated, detectable tape labeled "Reclaimed Waterline Buried Below" shall be placed in the trench backfill 2 feet above and directly over the pipe. Detectable tape shall be manufactured by Pro-Line, or CITY approved equal.

Following backfill and compaction of the water mains, cathodic protection test stations, shall be tested for effectiveness by the CONTRACTOR and the results of the continuity test shall be submitted to the CITY ENGINEER. If cathodic protection of the pipe is determined not to meet industry standards, then corrections shall be made until it meets industry standards and is accepted by the CITY ENGINEER.

11.33.03 Fittings

Pipes shall be connected to valves and fittings by mechanical joints unless specified differently in the approved drawings. For approved slip-on joints, the joint shall be assembled with a ratchet jack or other approved method in a manner that does not cause any damage to the pipe. Both the spigot and bell must be thoroughly clean and free from tar or other coatings and rust.

For mechanical joint pipe, the last 8 inches of the outside of the spigot end of the pipe and the inside of the bell of all 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 a thin film of gasket lubricant shall be applied. The cast iron gland shall then be slipped on the spigot end of the pipe with the lip extension of the gland toward the bell of the fitting. Gasket lubricant shall be applied to the rubber gasket and placed on the spigot end of the pipe with the thick edge towards the gland.

After the spigot end of the pipe is placed into the bell and fully inserted the gasket shall be pressed into place within the bell so it is even 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 in accordance with manufacturer's recommendations. Nuts spaced

180 degrees apart shall be tightened alternately to produce equal pressure on all parts of the gland. All fittings must have approved zinc caps and wax tape.

Jointing shall be done in accordance with AWWA Specification C-111, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings, for all mechanical joint fittings.

11.34.00 VALVE AND VALVE BOX INSTALLATIONS

In addition to the jointing requirements mentioned in Chapter 3 of these STANDARDS AND SPECIFICATIONS, the additional requirements of this section shall apply. Valves and valve boxes shall be installed where shown on the PLANS and as directed by the CITY ENGINEER. Valve boxes shall be firmly supported, centered, and plumbed over the operating nut of the valve with the box cover at or minus 1/4-inch within the surface of the finished pavement or at such other elevation as may be directed by the CITY ENGINEER. Extensions to within 4 feet of the finished grade shall be provided for valves installed with more than 5 feet of cover. All extensions shall be pinned to the valve operating nut. Earth fill shall be carefully tamped around each valve box to a minimum distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet. Valves shall have the interiors cleaned of all foreign matter before and after installation. For valve box installations in flow fill, pipe wrap must be used on the exterior of the valve box.

Gear cases shall be tightened and the valve shall be inspected in opened and closed positions to insure that all parts are in working condition prior to installation. The cases shall be supported by concrete blocks to prevent any shock or stress being transmitted to the valve.

11.35.00 THRUST BLOCKS

The CONTRACTOR shall excavate as required to ensure that the thrust blocks are placed against undisturbed soil and shall form the sides of the thrust block to provide the size and shape as required in the Standard Details in the Appendix of these STANDARDS AND SPECIFICATIONS. When it is impossible, because of over excavation or other causes, to pour a thrust block against undisturbed earth, harness rods shall be used to anchor the fittings to the main in addition to the thrust block and as required by the CITY ENGINEER. After the concrete has been placed and has set, the CONTRACTOR shall remove all forming materials prior to backfilling around the thrust block. Concrete for the thrust blocks shall comply with provisions set forth in Chapter 7 of these STANDARDS AND SPECIFICATIONS

The blocking shall be placed so that the pipe and fitting joints will be accessible for repair. A bond breaker shall be placed between the fittings and the thrust block. Backfill may be placed over the thrust blocks once the surface has set sufficiently to resist the weight of the backfill. However, no tamping or compacting shall be allowed above the thrust block for a minimum of 24 hours after placement. Concrete must set a minimum of 48 hours prior to the initial filling of the line.

11.36.00 CONNECTION TO EXISTING MAINS

At locations where connections to existing water mains are to be installed, the CONTRACTOR shall locate the existing mains, both vertically and horizontally, and shall verify their exact size in advance of the time scheduled for making the connections. The CONTRACTOR shall notify and schedule the connection with the CITY ENGINEER.

Prior to connecting to existing water mains, the CONTRACTOR shall have all personnel, materials, and equipment ready to connect the fitting to the existing main to keep the shut-off time to a minimum. As soon as possible after making the connections, the CONTRACTOR shall flush the connection to prevent any contamination of the existing facilities. The CONTRACTOR shall take every precaution necessary to prevent dirt or debris from entering the main. CONTRACTOR must use AWWA standards C651 and C655 for disinfection and flushing for all new water mains. Refer to PWU current approved service rules for detail on disinfection, flushing, testing, and connections.

11.37.00 FIRE HYDRANT INSTALLATION

No fire hydrants are allowed on the reclaimed water system.

11.38.00 TAPS

The size of tap and the tapping method for a given type and size of waterline shall be as follows. Transmission mains (16 inch pipes and larger) should not be tapped unless otherwise approved in writing by the CITY ENGINEER.

Host Pipe Size	Tap Size (DIP or PVC)			
	¾"	1"	1-1/2"	2"
6"	DT/S	DT/S	S	S
8"	DT/S	DT/S	S	S
10"	DT/S	DT/S	S	S
12"	DT/S	DT/S	S	S

S -- Tapping saddle required. All saddles shall have the AWWA taper on its threads.

DT -- Direct tap permitted.

DT/S -- Either a tapping saddle or a direct tap may be permitted depending on the situation.

All existing AC waterlines shall be tapped using a saddle.

¾" and 1" taps into the water main shall be at an angle of 45 degrees from the horizontal, and corporation stops shall be installed. 1 1/2" and 2" taps into the water main shall be at the 3 and 9 O'clock position, and corporation stops installed.

Taps shall not be made on a water main until the main has passed the pressure tests and clear water tests and a "Release For Service" letter has been issued by the CITY ENGINEER. Care shall be taken to properly install water service lines so that a

minimum of 12 inches of slack is in the service line at the main to protect against pull-out. Tapping mains may require digging out bedding material and cutting or removing part of the corrosion protective wrapping. After the taps are made, the wrap shall be repaired or replaced by the CONTRACTOR to protect both the service line and the main.

Service taps shall have a minimum separation of 24 inches and be no closer than 24 inches to a main line joint. There shall be no more than 4 taps per 20' section of pipe.

All service taps shall be performed by the CONTRACTOR. All necessary materials for said taps, including corporations stops, copper line, meter pits, copper setters, curb stops, etc., shall be supplied by the CONTRACTOR. Said materials shall conform to these STANDARDS AND SPECIFICATIONS. The CITY ENGINEER will inspect each tap prior to backfilling.

Taps to PVC mains shall be accomplished with the mainline valves either side of the tap in the closed position.

Taps to PVC mains shall only be made when the air temperature is 32°F or higher.

11.39.00 METER INSTALLATION

All meter installations shall be in accordance with the Standard Details in the Appendix of this Chapter.

No connections shall be made in the meter pit other than those related to the meter and bypass. Sprinkler system or backflow preventer connections shall be made no closer than five (5) feet from the meter pit or vault on the downstream side of the meter. The CITY will own and maintain the service line and fittings up to, and including the meter.

Residential 5/8" x ¾" meters with transponders shall not be allowed on the reclaimed water system. All other meters and associated transponders shall be purchased by the CONTRACTOR and then provided to the CITY for testing prior to installation. The CONTRACTOR shall contact the CITY's Meter Shop prior to purchasing meters and transponders to verify the type and brands that are required. The CONTRACTOR shall also contact the CITY's Meter Shop to make an appointment for delivery of said meter(s) to the Shop for testing. The location of installation and manufacturers information shall accompany the meter when delivered by the CONTRACTOR to the CITY. The meter will be tested and CONTRACTOR must call to schedule the meter pit/vault inspection. In addition, the following specific standards shall apply:

11.39.01 3/4-Inch and 1-Inch Meter Installations

The ¾" and 1" meter sets are not allowed on the reclaimed water system.

11.39.02 1-1/2-Inch and 2-Inch Meter Installations

The 1 ½" and 2" meter sets shall be installed in accordance with these STANDARDS AND SPECIFICATIONS and the Standard Details in the appendix of this Chapter. Meter manhole lids shall be a maximum of 2 inches above the approved final grade.

The meter manhole shall be located a minimum of 3 feet behind sidewalk and in no case shall the manhole lid be located more than 10 feet from the back edge of curb. Where no sidewalk exists, the meter shall be placed a maximum of 6 feet behind the back of curb. In detached walk areas the meter shall be placed 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the walk to the edge of the meter lid. A curb stop is required on the service line behind the back of curb and outside of the manhole. In all cases, the meter manhole shall be installed within the RIGHT-OF-WAY or public Utility Easements. No meter manholes shall be set in streets, concrete areas, driveway alignments, or other traffic area without specific design and prior approval of the CITY ENGINEER.

Meter manholes shall use a 24 inch aluminum ring and cover and the outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set then a 12" wide by 6" thick concrete collar shall be placed around the manhole ring. The manhole cover shall have a 2 inch diameter recessed hole in the center of the cover for the transponder and the cover shall have the lettering "Reclaimed Water Meter" cast into the lid. Meter manholes in traffic areas are only allowed at the discretion of the CITY ENGINEER. If allowed, the manhole shall use a 24 inch aluminum ring and cover and shall be designed to accommodate and protect the transponder. Approval by the CITY ENGINEER of this design will be on a project specific basis.

11.39.03 3-Inch and Larger Meter Installations

The 3" and larger meter sets shall be installed in accordance with these STANDARDS AND SPECIFICATIONS and the Standard Details in the Appendix of this Chapter. The entry hole through the roof of the vault shall be aligned perpendicular to the service line and adjacent to the water meter. Vaults shall be sealed at all joints and made watertight. Meter vault lids shall be a maximum of 2 inches above the approved final grade.

The meter vault shall be located a minimum of 5 feet behind sidewalk or back of curb and no more than 10 feet from the back of curb. Where no sidewalk exists, the meter shall be placed a maximum of 6 feet behind the back of curb. In detached walk areas the meter shall be placed 6 feet behind the back

edge of curb but no closer than 18 inches from the front edge of the walk to the edge of the meter lid. A curb stop is required on the service line behind the back of curb and outside of the vault. In all cases, the meter vault shall be installed within the RIGHT-OF-WAY or public Utility Easements. No meter vaults shall be set in streets, concrete areas, driveway alignments, or other traffic area without prior approval of the CITY ENGINEER.

Meter vaults shall use a 24 inch aluminum cover and shall have the lettering "Reclaimed Water Meter" cast into the lid. A 24" x 36" aluminum cover adaptor and ring shall be used to enlarge the access opening and the adaptor shall have a 2 inch diameter hole for the transponder.

The outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set then a 12" wide by 6" thick concrete collar shall be placed around the manhole ring. Meter manholes in traffic areas are only allowed at the discretion of the CITY ENGINEER. Approval by the CITY ENGINEER of the design for traffic areas will be on a project-specific basis.

PVC pipe shall be used on the service line outside the vault, except where the pipe stubs through the vault walls. DIP shall be used inside the vault. For all 3 inch and 4 inch meter settings, 4 inch service pipe will be required on the CITY side of the meter. A reducer will be required before the meter and on the bypass for 3 inch settings. Insulators shall be provided between connections of dissimilar metals. Meter installations larger than 3 inch and larger shall require shop drawing submittals for approval.

Final inspections of the meter manhole will be made at the time the meter is set. Meter will be set by the CONTRACTOR if the meter manhole passes inspection. CONTRACTOR must call 303-658-2549 to schedule final inspection. CONTRACTOR will warranty meter manhole and appurtenances for a period of 2 years after final inspection has passed.

11.40.00 TESTS

11.40.01 General

The CONTRACTOR shall flush and test all mains regardless of existing conditions. This may include repairing existing facilities that must be included in the test and are not capable of holding test pressures. All thrust blocks or other bracing facilities shall be in place at least 48 hours before the initial filling of the line. All tests will be observed by the CITY ENGINEER.

11.40.02 Filling and Venting Lines

All valves will be operated by the Public Works & Utilities Department. The line shall be slowly filled with water and all air expelled from the pipe. Care shall be taken so that all available hydrants (including hydrant gate valves),

air valves, and other vents are open during the filling of the line. Where hydrants or other vents are not available in the line, the CONTRACTOR shall make whatever taps are required for venting purposes. These taps shall be abandoned after pressure and disinfection tests have passed and the line has been completely flushed as required by the Public Works Department. Following testing, the taps shall be removed back to the main and the main repaired by the use of a stainless steel repair clamp. The rate of filling the line shall not exceed the venting capacity of the vent.

11.40.03 Disinfection

The disinfection test is not required for reclaimed water systems.

11.40.04 Flushing the Main

The entire line shall be flushed with potable water after installation is complete. Such flushing shall continue until the water is clear, the line is flushed appropriately, and per direction of the CITY. The entire line, including branch lines and dead-end mains shall be flushed. The discharge of flushed water shall be accomplished such that no erosion will occur and with no harm to fish, animals, or plants in accordance with Federal and State regulatory agencies.

The Water Quality Control Division of the CDPHE requires all water line CONTRACTORs to possess a current Discharge Permit for discharges of chlorinated and process waters associated with the installation of new mains or conduits. Contact CDPHE Water Quality Control Division at 303-692-3539 for information on obtaining the required permit. Procedures for discharge will be subject to the review of the CITY ENGINEER.

11.40.05 Pressure Test

After the pipe and appurtenances have been laid, the line has been backfilled, disinfection and flushing of the system has occurred and all field-place concrete has cured in accordance with these STANDARDS AND SPECIFICATIONS each valved section, unless otherwise directed by the CITY ENGINEER, shall be subjected to a hydrostatic pressure of not less than 150 psi. However, in all cases the test pressure shall be 50 percent over existing main pressure in the test area as measured at the lowest elevation of the water main. The test duration shall be a minimum of one hour. If the test pressure drops more than 5 p.s.i. during the test, measured water shall be added to the test section to bring the section up to the specified test pressure. Water added to maintain the pressure shall be per AWWA C600-05 and AWWA C605-05. Allowable leakage shall be calculated according to the following formula:

Ductile Iron and PVC Pipe:

$$L = \frac{N \times D \times \sqrt{P}}{148{,}000}$$

L = Allowable Leakage in gallons per hour N = Total length of pipe being tested in feet D = Nominal diameter of pipe in inches

P = The average test pressure in psi

Each test section of pipe 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 connected to the pipe in a satisfactory manner. The pump, pipe connection, gauges, and all necessary apparatus and labor shall be furnished by the CONTRACTOR. Gauges and measuring devices shall be approved by the CITY ENGINEER. Before applying the specified test pressure all air shall be expelled from the pipe. Any cracked or defective pipes, fittings, valves, or hydrants discovered in the pressure test shall be removed and replaced by the CONTRACTOR with sound material including any existing pipe or appurtenances that are leaking and were included in the test section. After all visible leaks have been repaired; the pressure test shall be conducted again. Should testing show a leakage rate in excess of the rates calculated from the formula above, the pipeline shall not be accepted. The pipeline shall be repaired and retested as described in this section until it meets the test requirements and is accepted by the CITY ENGINEER.

11.40.06 Bacteriological and Turbidity Test

The bacteriological test is not required for reclaimed water systems.

Water from all new reclaimed water mains and appurtenances must successfully pass a turbidity test before the main is placed in service. After final flushing, an acceptable sample shall be collected from the new mains and appurtenances. A sample shall be collected for every 800 feet of new pipe.

All sampling shall be performed by the CITY ENGINEER.

11.40.07 Cathodic Protection System Testing

Following construction of water mains and other appurtenances requiring cathodic protection, the following tests shall be performed:

1. Test the pipe-to-soil voltage potential by comparing to a copper sulfate half-cell. One lead of the volt meter is connected to the pipe lead and the other is connected to the copper sulfate half cell buried in moist

in-situ soil near the pipe installation. The potential shall read 0.85 volt or higher. A value of 0.80 volts or less means the pipe is corroding.

2. Check the continuity of the pipe. Prior to completely backfilling the pipe an ohmmeter shall be connected between each end of the installed pipe to measure an ohm reading. Next, test between the test box lead wire and the pipe. A reading of 3 ohms or less shall be achieved for both tests.

3. Test the voltage output of the anode. As in test one above, connect the voltmeter to the anode lead wire and the other lead to the copper sulfate half cell. The voltage reading shall be between 1.4 and 1.6 volts.

4. Measure the current flow from the anode to the pipe. The volt meter is connected to the anode test lead and the other voltmeter lead is connected to the pipe test lead in the test box. The reading shall be between 0.005 amp and 0.3 amp. If the current is more than 1.3 times the design needs, a resistance shall be added to the circuit to extend the life of the anodes.

11.40.08 <u>Cross Connection Test</u>

The CITY requires all new and retrofit sites to pass a cross connection test upon being connected to the reclaimed water system, and the site must pass the test before the site can receive final approval. The completion and cost of the test shall be the CONTRACTOR's responsibility. Pass or fail shall be determined by the CITY ENGINEER, and a CITY INSPECTOR and/or Reclaimed Water System Analyst shall be present for the cross connection test.

The test shall be by one of two methods: (1) injection of dye into the irrigation system or (2) completion of a shutdown test. The CITY reserves the right to select the test method.

The dye test consists of injecting dye through the backflow device and moving the dye around the site by opening irrigation valves or utilizing quick couplers. Once the dye is in place, the CONTRACTOR operates multiple outlets of the site's potable water system (e.g. hosebibs, faucets, drinking fountains, etc) for 3-5 minutes each to check for dye in the water. If dye is detected in the potable system, then the test reveals a cross connection.

The shutdown pressure test consists of shutting off the potable water source and testing for any changes in pressure in that system, then testing the reclaimed water source similarly. First, the potable source on site is shut off. Add pressure gauges to the system or open hose bibs/faucets. If there is no pressure increase as measured by the gauges, or there is no flow from the hose bibs/faucets, then the potable water is restored. The same process is repeated for the reclaimed system to check for any increases in pressure in that system. If one or both of the checks fail, then the test reveals a cross connection.

If the chosen test reveals a cross connection, the CONTRACTOR shall be responsible for any and all repairs needed to eliminate the cross connection. The CONTRACTOR shall then repeat the cross connection test at the CONTRACTOR's expense until no cross connection is found.

11.50.00 MATERIALS

11.51.00 GENERAL

In accordance with CITY CODE, only purple colored PVC pipe shall be approved for reclaimed water distribution main installations. Any other material proposed must be approved by the CITY ENGINEER in writing, prior to construction. All materials furnished shall be new and undamaged. Transmission mains, 16 inches in diameter and larger, may be purple colored ductile iron pipe or steel pipe at the discretion of the CITY ENGINEER.

Acceptance of materials or the waiving of inspection thereof shall in no way relieve the DEVELOPER of the responsibility for furnishing materials meeting the requirements of these STANDARDS AND SPECIFICATIONS. The CITY reserves the right to direct or deny the use of certain types of materials in specific circumstances. All materials delivered to the job site shall be adequately housed and protected to ensure the preservation of their quality for the work. The presence of any defects in any materials may constitute sufficient cause for rejection of the pipe or appurtenances. Rejected materials shall be removed from the work site unless otherwise permitted by the CITY ENGINEER.

11.52.00 PIPE

11.52.01 Ductile Iron Pipe (DIP)

All ductile iron pipe shall be manufactured in accordance with AWWA Standard C-151 current standard (include zinc coated pipe), Ductile Iron Pipe Centrifugally Cast for Water. Pipe furnished under this specification shall conform to pressure class 350.

Ductile iron pipe shall be approved for fire hydrant laterals, pipe stubs through walls (as required) and other applications as approved by the CITYCITY ENGINEER in writing.

The joint type shall be "push-on, single-gasket" type conforming with applicable requirements of AWWA Standard C-111 current standard, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings. Joint types other than "push-on, single-gasket" are acceptable only if specifically approved by the CITY ENGINEER in writing.

Pipe shall have normal laying length of either 18 feet or 20 feet. Random lengths are not acceptable.

Grade of Iron used in the manufacture of pipe shall have 60/42/10 physicals in accordance with AWWA C-151.

Pipe shall have standard thickness cement mortar linings in accordance with AWWA Standard C-104-13, Cement Mortar Lining for Ductile Iron Pipe and Fittings. Pipe shall have a standard asphaltic coating on the exterior

The weight, pressure class or nominal thickness, and casting period shall be shown on each pipe. The manufacturer's mark, the year in which the pipe was produced, and the letters "DI" or

"Ductile" shall be cast or stamped on the pipe. IAW AWWA C-151 current standard.

11.52.02 <u>Polyvinyl Chloride Pipe (PVC)</u>

All PVC pipe shall meet the requirements of AWWA Specification C-900 current standard, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (4" - 12"), and shall be Pressure Class 305 psi (DR 14), or AWWA C-905 current standard, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (14" - 48"), and shall be Pressure Class 235 psi (DR 18).

All pipe shall be suitable for use as a pressure conduit. Provisions must be made for expansion and contraction at each joint with a rubber ring. The bell shall consist of an integral wall section with a solid cross-section rubber ring which meets the requirements of AWWA Specification C-900 current standard.

Standard laying lengths shall be twenty feet (20') for all sizes. Random lengths shall not be acceptable.

Each length of pipe shall bear the date manufactured, type, grade, length, manufacturer's name, and NSF seal of approval.

Pipe joints shall be made using an integral bell with an elastomeric gasket push-on type joint or using machined couplings of a sleeve type with rubber ring gaskets and machined pipe ends to form a push-on type joint.

Solvent cement joints are strictly prohibited.

The manufacturer shall furnish a certified statement that all of the specified tests and inspections have been made and the results thereof comply with the requirements of the applicable standard(s) herein specified. A copy of the certification shall be sent to the CITY ENGINEER upon request.

The following test station box has been approved by the CITY for use with tracer wire installations:

Valvco, Terminal Box #NM (5" ID) without locking lid

Others as approved in writing.

11.52.03 Steel Pipe

Upon approval by the CITY ENGINEER, the use of steel pipe may be allowed for transmission mains 16 inches in diameter or larger. The pipe shall meet Standard AWWA C-200 current standard, Steel Water Pipe 6 inch and Larger, and installed accordingly. Detailed specifications shall be as approved by the CITY ENGINEER on a case-by-case basis.

All new steel mains shall require cathodic protection and shall be designed by a qualified Cathodic Protection Engineer, registered in the State of Colorado. Cathodically protected pipe shall also require polyethylene wrap as described in section 11.61.02.

11.53.00 FITTINGS

All mechanical joint fittings shall be manufactured in accordance with AWWA C110 current standard, Ductile Iron and Gray Iron Fittings, or AWWA C153 current standard, Ductile Iron Compact Fittings. Fittings shall be furnished with rubber gasket joints in accordance with AWWA C111 current standard, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

All fittings shall be 350 PSI pressure rating and shall conform to the dimensions and weights shown in the tables of the above referenced AWWA Standards. All fittings shall be made from gray iron or ductile iron. The manufacturer shall prepare a certified statement that the inspection and all of the specified tests have been made and the results thereof comply with the requirements of the applicable Standard(s) herein specified. A copy of the certification shall be sent to the CITY ENGINEER upon request.

All ductile iron flanged fittings shall be manufactured in accordance with AWWA C110 current standard for integrally cast flange fittings or AWWA C115 current standard, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges, for threaded flange fittings. Typical ductile iron flanged fittings shall be rated for 250 psi working pressure. A working pressure of 350 psi may be achieved with the use of special gaskets.

The following are additional requirements or exceptions to the standards mentioned above:

All fittings 4” through 16” shall be furnished with a fusion bonded epoxy inside and out, with a standard thickness as defined in AWWA C116 current standard , Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings. The requirement for fusion bonded epoxy on fittings may be waived by the CITY ENGINEER if specific fittings are not available.

All fittings shall be furnished complete with tee-head mechanical joint bolts and hexagon nuts and shall be fabricated from a high strength, low alloy steel known in the industry as "Cor-Ten" or approved equal.

Mechanical joint anchoring fittings (swivel) as approved by the CITY ENGINEER, in writing, may also be used.

11.54.00 VALVES

11.54.01 General

All valves shall open left (counterclockwise). Valves shall have a 2-inch-square operating nut. Extension stems shall be pinned to the operating nut for a secure connection. Set screw type connections will not be allowed.

All buried valves shall be installed with a valve box meeting the material specifications of these STANDARDS AND SPECIFICATIONS.

11.54.02 Gate Valves

Gate valves shall be required for 4 inch through 12 inch valve sizes, unless approved otherwise by the CITY ENGINEER in writing. Gate valves shall be iron body, resilient-seated gate valves with non-rising bronze stems with design, construction, and pressure ratings conforming to AWWA Specifications C-509 current standard, Resilient Seated Gate Valves, or C515 current standard, Reduced Wall Resilient Seated Gate Valves, and with modifications specified herein. Stem seals shall be triple "O" ring seals designed so that the seals above the stem collar can be replaced with the valve under pressure and in full open position.

Gate valves approved by the CITY shall be one of the following types:

American Flow Control, Series 2500 (C515 only)
Mueller, Series 2361, 2362
American AVK, Series 25, 45, 65
CLOW Valves, Models 2639 and 2640

With the exception of tapping valves and valves in vaults, gate valves shall have mechanical joint ends.

Gate valves requiring flanged ends shall have dimensions and drilled holes that conform to ANSI B16.1, Class 125. Flange faces shall be machined to a flat surface with a serrated finish in accordance with AWWA C207 current standard, Steel Pipe Flanges (4 in. through 144 in). Tapping valves and valves in water vaults for 3” and larger meters shall have a flange connection on one side of the valve and a mechanical joint on the other side (refer to section 3.60.04 for approved tapping valves).

All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116 current standard, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550 current standard, Protective Interior Coatings for Valves and Hydrants. The coating shall be a two-part thermosetting epoxy suitable for field over coating and for touch-up with the same coating material without special surface preparation. The supplier shall furnish detailed performance tests of adhesion, hardness and abrasion resistance of the furnished coatings when requested by the CITY ENGINEER. The coating shall have a successful record of performance in valves, pipe or other fittings for a minimum of ten years.

The resilient seat gate valve stem shall have external break-off capabilities for over-torquing and positive stop to prevent over compression.

All external bolts, nuts and washers used in conjunction with valves shall be stainless steel and tee-bolts shall be "Cor-Ten" with zinc caps. Valves shall be delivered complete with bolts, glands and rubber gaskets in conformance with AWWA C111 current standard, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

11.54.03 Butterfly Valves

Butterfly valves shall be required for 16 inch and larger valves, unless approved otherwise by the CITY ENGINEER in writing. All butterfly valves shall be installed in a vault in accordance with the Standard Details in the Appendix of this Chapter. Butterfly valves shall have a combination air and vacuum valve installed on both sides of the valve.

Butterfly valves approved by the CITY shall be one of the following types:

Mueller, Lineseal III and XPII (sizes up to 48")
Pratt, Triton XR-70 (sizes 24" to 72"),
K-Flo, 500 Series (sizes up to 20")

Butterfly valves shall be geared and designed for underground service and shall conform to current AWWA Specification, Rubber Seated Butterfly Valves, Class 150-B. Valves shall be tight closing rubber seat type with the rubber seats bonded to the valve body. No metal to metal sealing surfaces will be permitted. Valves shall be bubble tight to 150 PSI minimum rated pressure with flow in either direction. Valve discs shall rotate 90 degrees from the full open position to the shut-tight position. Valve bearings shall be sleeve-type corrosion-resistant, and self-lubricating with the load not to exceed 2,500 PSI.

All butterfly valves shall be furnished with flanged ends. Dimensions and drilling shall conform to ANSI B16.1, Class 125. Flanges shall be machined to a flat surface with a serrated finish in accordance with AWWA C207 current standard, Steel Pipe Flanges (4 in through 144 in). The flanges shall have full-sized bolt holes through the flanges, except that drilled and tapped holes will

be acceptable only in the areas where the shaft passes through the body. Flanges with all holes tapped will not be allowed.

All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116 current standard, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550 current standard, Protective Interior Coatings for Valves and Hydrants.

All external bolts, nuts and washers used in conjunction with valves shall be stainless steel and tee-bolts shall be "Cor-Ten".

11.54.04 Valve Boxes

Valve box lids shall be triangular and marked with the words “RECLAIMED WATER,” and shall have a lip or flange extending into the valve box shaft. No slip-type boxes will be allowed.

Valve box lids for buried gate valves shall be the following type or CITY ENGINEER approved equal:

East Jordan Iron Works, No. COM120120A01

11.55.00 FIRE HYDRANTS

Fire hydrants shall not be installed on reclaimed water lines.

11.56.00 BLOW-OFFS

Blow-offs shall not be installed on reclaimed water lines, except per the direction of the CITY ENGINEER.

11.57.00 MANHOLES AND VAULTS

11.57.01 General

Manholes, Vaults and associated components (i.e. manhole sections, lids, walls and base slabs) shall be designed in accordance with ASTM C 857 and ASTM C 858 to handle applicable loads, including earth, thrust and live loads. Concrete shall have a minimum 28 day mix design of 5,000 psi. All concrete structures shall be designed for HS-20 loading in accordance with AASHTO Standards. Concrete structures shall be manufactured by facilities certified by the National Precast Concrete Association (NPCA). Concentric reducing sections for manholes shall not be used.

Vaults shall be cast with a separate roof slab for removal and shall be 8 inches minimum thickness. Vault walls shall be cast in one continuous placement and corners shall have added reinforcement as shown in the standard detail in the appendix of these Standards and Specifications. Minimum wall thickness shall be 6

inches and reinforcement shall be at least one inch from the face of the vault. Shop drawings for vault designs shall be submitted to the CITY ENGINEER and shall be signed and sealed by a Professional Engineer registered in the State of Colorado.

Steps shall be ½" minimum diameter steel reinforcing bar with a polypropylene plastic covering. Steps shall be placed 12 inches on center and 18 inches maximum from the top of the ring to the first step. Steps shall align with one another in a straight vertical line. Steps shall be PS2-PF manufactured by M.A. Industries, Inc., or CITY approved equal.

11.57.02 <u>Rings and Covers</u>

All gray iron manhole rings and covers shall conform to the requirements of AASHTO M 105 Class 35B or ASTM A48 Class 35B. Ductile Iron castings shall conform to the requirements of ASTM A536 Grade 80-55-06. Aluminum castings shall conform to the requirements of ASTM B 26 Alloy 356 or 319. All castings shall conform to Federal Specification RR-F-621E, for shape and dimension required and shall have a minimum traffic load rating of AASHTO H20-44.

Each casting shall have markings by the foundry showing: name of foundry, country of manufacture, AASHTO or ASTM designation number, Class number and letter and cast date. Lids shall have lettering, and CITY logo, as shown in the detail drawings in the appendix of this chapter. CITY logo is required on all castings except valve box covers and meter pit lids for meters 2 inch and smaller.

Castings shall be free from plugging, sand, blowholes, shrinkage, cracks, and other cold shuts and be well cleaned by shot blasting. Runners, risers, fins, and other cast-on pieces shall be removed from the castings and ground smooth. Bearing surfaces between manhole rings and covers shall be cast or machined with such precision that a uniform bearing surface shall be provided throughout the perimeter area of contact.

Covers shall be 23-7/8" in diameter and frame or ring height shall be 5-1/4" tall in accordance with the standard detail in the appendix of these Standards, or as otherwise approved in writing. Concrete extension collars shall be used to adjust the manhole ring and cover to approved street or ground surface.

Gray iron ring and covers shall be the following type or CITY approved equal:

East Jordan Iron Works, Product No. 00245511 (36" diameter hub)
East Jordan Iron Works, Product No. 00245521 (36" diameter outer cover)
East Jordan Iron Works, Product No. 00240588 (24" diameter inner lid)

Aluminum rings and covers shall be the following type or CITY approved equal:

Castings Inc., Model MH-100-24 AL

11.57.03 Base Slabs and Base Beams

When required, manhole base beams shall be precast, reinforced concrete. The beams shall be 12 inches wide by 9 inches deep by 8 feet long. The reinforcement shall consist of three No. 5 bars longitudinally and No. 4 bars at 12-inch centers transversely.

Base slabs may be poured in place or precast. The slab shall be designed to uniformly support AASHTO H-20 traffic loading and any earth loading. The minimum slab thickness shall be 6 inches. The minimum reinforcement in the base slab shall conform to the detail drawings in the Appendix of this chapter.

11.57.04 Joint Material

Joint material used to join all sections shall be a flexible butyl resin joint sealing compound meeting Federal specifications SS-S-210-A and AASHTO M-198-B. Joint material shall be Ramnek, or CITY approved equal.

11.57.05 Mortar

Mortar used in repair of precast sections and for grouting joints shall be composed of one part Portland cement and not more than three nor less than two parts of fine aggregate. Hydrated lime or masonry cement shall not be used. Portland cement shall meet the requirements of ASTM C-250, Type II. Fine aggregate shall consist of well-graded natural sand having clean, hard, durable, uncoated grains, free from organic matter, soft or flaky fragments or other deleterious substances. The fine aggregate shall be thoroughly washed and shall be uniformly graded from coarse to fine with a minimum of 95 percent passing a No. 4 sieve and a maximum of 7 percent passing a No. 100 sieve.

11.58.00 VAULT ELECTRICAL AND MECHANICAL

Electrical and mechanical panels shall be installed in a cabinet above ground in a convenient location. The panels shall be designed and installed per the direction of the CITY ENGINEER.

11.59.00 VENT PIPES

For typical above ground vent pipe installations, vent pipes shall be 3-feet tall and 8-inch diameter seamless pipe in accordance with the details in the appendix of these Standards and Specifications.

Below-ground, vent pipes shall be 6-inch diameter, SDR 35 or Schedule 40 PVC in accordance with the details in the appendix of these Standards and Specifications.

11.60.00 SERVICE CONNECTIONS

11.60.01 Pipe

Acceptable material for 1/12" and 2" service lines is seamless copper tube and for 4" and larger service lines PVC pipe shall be used. All service pipes shall conform to one of the following specifications.

(A) Seamless copper tube designated as "Type K" (soft) in the industry shall be used for 1-1/2" and 2" service lines. Service pipe and fittings 1-1/4" in diameter are prohibited. Seamless copper tube service pipe shall be installed with purple colored poly wrap per Section 11.61.02.

(B) PVC pipe conforming to Chapter 3 of these STANDARDS AND SPECIFICATIONS shall be used for 4-inch and larger service lines. Three-inch service pipe is not readily available and service pipe specified as 3-inch shall be upsized to 4-inch from the main connection to the meter pit.

11.60.02 Saddles

For 1 ½" and 2" taps requiring saddles, the saddles shall be AWWA taper thread (CC thread) and shall be manufactured in accordance with AWWA C-800 current standard, Underground Service Line Valves and Fittings. Cast saddle top, strap, and nuts shall be constructed of ASTM A-536 Class 65-45-12 stainless steel.

The following saddles have been approved for use with ductile iron, cast iron, AC or PVC host pipes, 6" through 12":

	1½"	2"
McDonald	---------- 3825 Series ----------	
Ford	---------- FC202-905 Series ----------	
Mueller	---------- BR2B Series ----------	
Ford (stainless)	---------- FS202-905-Series ---------	

11.60.03 Curb Stop Valves and Curb Stop Boxes

All curb stops shall be manufactured in accordance with AWWA C800 current standard , Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62. Curb stop valves shall be ball type with a maximum working pressure of 300 psi and shall have compression fittings.

Curb stop valves for use with copper service pipe shall be the following type:

	1½"	2"
McDonald	6100Q	6100Q

Ford	B44-666-G	B44-777-G
Mueller	B-25209	B-25209

All curb stops shall have a valve box per 11.54.04 of this section.

11.60.04 Tapping Sleeve and Valve

Tapping sleeves shall be required on existing host pipe for all taps larger than 2 inch, unless a tee is provided**.**

Cast or Ductile Iron Host Pipe

Full body Mechanical Joint (MJ) cast or ductile iron tapping sleeves are required.

Tapping sleeves for Cast Iron or Ductile Iron shall be the following type:

Mueller H-615
Waterous Series 1004 or 2800
US Pipe T-9
Tyler/Union Compact (up to 12")

PVC or AC Host Pipe

Fabricated stainless steel triangular sidebar style with stainless steel flange tapping sleeves are required. No coated carbon steel saddles will be allowed. A flange insulator kit between the valve and sleeve is required. Stainless steel bolts will be required on the tapping sleeve side of the valve. Tapping sleeve shall be rated for 250 PSI minimum operating pressure (sizes 4"-12") and 200 PSI minimum operating pressure for larger sizes.

Tapping sleeves for PVC or AC host pipes shall be the following type:

JCM 432 or 452
Mueller H-304
Ford FTSS
Romac SST III or STS 420
Smith Blair 665

Steel Host Pipe
Weld on Saddles shall be required. These taps are application specific and require approval by the CITY ENGINEER.

Tapping valves shall be resilient seat, cast iron or ductile iron body, fully bronze mounted with non-rising stem and shall be in conformance with section 3.54.02 of these Standards and Specifications. Tapping valves shall have a flange connection on one side meeting the requirements of ANSI B16.1 Class 125 and a mechanical joint on the other side meeting AWWA C111

current standard, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings. Valves shall be delivered complete with bolts and gaskets.

Tapping sleeves for Steel host pipes shall be the following type or CITY approved equal:

Mueller, Series 2360 (sizes 4" – 12")
American AVK, Series 45 (sizes 4" – 12")

11.60.05 Corporation Stops

All corporation stops and threaded brass fittings shall be manufactured in accordance with AWWA C800 current standard, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62. All corporation stops shall be tested at the factory and shall meet the following minimum physical requirements:

Tensile strength	30,000 PSI minimum
Yield Strength	14,000 PSI minimum
Elongation in 2 inches	20 percent minimum

Corporation stops shall be ball valve type designed for a maximum working pressure of 300 psi. The inlet side shall have AWWA taper thread (CC thread) and the outlet side shall have a compression fitting.

Corporation stops shall be the following type:

	1½"	2"
McDonald	---------- 4701BQ ----------	
Ford	FB1000-6-G	FB1000-7-G
Mueller	---------- B-25008 ----------	

11.60.06 Stop and Waste

Stop and waste valves must be approved by CITY ENGINEER.

11.60.07 Compression Couplings

Only compression fittings will be allowed on copper service pipe. All compression couplings shall be manufactured in accordance with AWWA C800 current standard, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62.

Compression couplings shall be the following type or CITY approved equal:

Ford: C44-G Series (Grip Joint Connection)
McDonald: 74758-22
Mueller: H-15403

Upsizing of service lines after the meter shall be in accordance with the detail drawing of this chapter. Compression couplings for upsizing shall be the following type or CITY approved equal:

	1½" to 2"	2" to 3"
McDonald	n/a	n/a
Ford	C44-67-G-NL	n/a
Mueller	H-15403	n/a

11.61.00 ENCASEMENT

11.61.01 Concrete

All concrete shall be a minimum of Class D and shall conform with Chapter 7 of these STANDARDS AND SPECIFICATIONS. All concrete encasements shall be a minimum of 6 inches thick from outside of pipe to outside of encasement. Reinforcement for pipe encasements shall include #4 "hoop" reinforcement steel on 12" centers transverse and longitudinal #4 reinforcement placement shall conform with the Standard Details in the Appendix of these STANDARDS AND SPECIFICATIONS. Material properties for reinforcing steel shall conform with these STANDARDS AND SPECIFICATIONS.

11.61.02 Polyethylene Encasement

Polyethylene encasement material shall be a minimum of 8 mils thick and shall be a high density, cross-laminated polyethylene film. All polyethylene encasement material shall be manufactured in accordance with ANSI/AWWA Standard C-105/A21.5-05, Polyethylene Encasement for Ductile Iron Pressure Pipe and Fittings. The raw materials used to manufacture polyethylene film shall be Type I, Class A, Grade E-1 in accordance with ASTM Standard Designations D-1250. Polyethylene encasement material shall be purple colored.

11.61.03 Extruded Polystyrene Insulating Foam

"Extruded Polystyrene Insulating Foam" or "Rigid, Cellular Polystyrene Thermal Insulation" also referred to as "XPS" shall be manufactured in accordance with ASTM C 578-08b. Bonding sheets of "XPS" together shall be accomplished by using "3M 78 Polystyrene Foam Insulation Spray Adhesive" or CITY approved equal.

11.62.00 METERS

11.62.01 General

Contact the CITY Water Meter Shop (extension 2549) for proper meter for application. Approval of the meter by size, type, and brand shall be obtained from the CITY Meter Shop prior to purchasing the meter. All meters shall be purchased by the CONTRACTOR and delivered to the CITY Meter Shop to be pre-tested prior to installing the meter in the meter setting in accordance with Section 11.39.00 of these STANDARDS AND SPECIFICATIONS.

11.62.02 Magnetic Drive Positive Displacement-Type Reclaimed Water Meters

Contact the CITY Water Meter Shop (303-658-2549) for proper meter for application.

11.62.03 Turbine Meters

Contact the CITY Water Meter Shop (303-658-2549) for proper meter for application.

11.62.04 Mastered Meters

No mastered meters on the reclaimed water system shall be connected to fire hydrants or fire protection lines.

11.62.05 Meter Bypass Line

No bypass lines are allowed on reclaimed meters, pits, or vaults.

11.62.06 Meter Check Valves

For 1-1/2" and 2" meter installations, single check valves shall be installed inline with the service pipe and downstream of the meter setter in accordance with the standard details of this Chapter. Single check valves shall be manufactured in accordance with AWWA C800 current standard, Underground Service Line Valves and Fittings, and castings shall be constructed of brass in accordance with ASTM-B62.

Single check valves for 1-1/2" and 2" meter installations shall be the following type or equal as approved in writing by the CITY ENGINEER:

Ford HS11-666 (1-1/2"); HS11-777 (2")

For 3" and larger meter installations, swing check valves shall be installed downstream and adjacent to the meter as well as on the bypass. Swing-check valves shall be manufactured in accordance with AWWA Standard C-508 current standard, Swing-Check Valves for Waterworks Service (2 in through 24 in) and shall have interior epoxy coating in accordance with AWWA Standard

C-550 current standard, Protective Interior Coatings for Valves and Hydrants. Swing check valves shall have an outside lever and weight and shall have metal seats. Swing check valves shall be iron body bronze mounted with flanged ends in accordance with ANSI B16.1.

Swing check valves for 3" and larger meter installations shall be the following type:

American Flow Control, Series 52-SC and 600
AVK, 41 Series
Mueller, A-2600-6-01
Kennedy, Style 1106

11.62.07 <u>Meter Valves</u>

Meter valves for 1 1/12" through 2" services shall be manufactured in conjunction with the setter. Valve shall be an angle lock wing type ball valve and shall be on the inlet and outlet sides for 1-1/2" and 2" setters.

For valves 4" and larger, gate valves shall be used and shall conform to Section 3.54.02 of these STANDARDS AND SPECIFICATIONS.

11.62.08 <u>Meter Yokes (Setters)</u>

All meter setters shall be manufactured in accordance with AWWA C800 current standard, underground Service Line Valves and Fittings, and all castings shall be constructed of brass in accordance with ASTM-B62. Meter setters shall be designed in accordance with the detail drawings in the appendix of this chapter.

The following meter setters: shall be the following type:

	¾"*	1**	1½"***	2"***
McDonald	732-3-09WX2233	732-4-WX2244	720B618WWFF665	720B718WWFF775
Ford	VB83-9W-44-33-G	VB84-10W-44-44-G	VBB76-18B-11-66-G	VBB77-18B-11-77-G
Mueller	B-2474N	B-2474N	B-2474N	B-2474N

* 9" setter height
** 10" setter height.
*** 12" setter height. Requires bypass piping.

Bypass orientation will not be allowed on a meter setter solely dedicated for irrigation use.

For installation of a smaller meter on an existing setter, size changes shall be accomplished by providing a full sized meter vault and setter for the line size installed and using industry standard adapters to install a reduced size meter

in the full size line. Adapters: shall be the following type or CITY approved equal:

1 ½" meter on 2" line	- 1 pair Ford A67 adapters
1" meter on 2" line	- 1 pair Ford A47 adapters
1" meter on 1 ½" line	- 1 pair Ford A46 adapters
5/8" X ¾" meter on 1" line	- 1 pair Ford A24 adapters
Other sizes	- Contact Utilities/Meter Shop

11.62.09 <u>Valve and Meter Supports</u>

Meter supports shall be fabricated of concrete and valve supports shall be fabricated of steel in conformance with detail W13 of these STANDARDS AND SPECIFICATIONS.

11.62.10 <u>Meter Pits (3/4" and 1" service lines)</u>

No new ¾" or 1" service lines are allowed on the reclaimed water system. Customers that have an existing ¾" or 1" service line that requires repair or modification shall contact the CITY Water Meter Shop (303-658-2549).

11.63.00 PRESSURE-REDUCING VALVE

All pressure-reducing valves shall be approved by CITY ENGINEER. The valve shall be designed to reduce a high upstream pressure to a constant downstream pressure by way of a pilot control system. The pilot system shall control the main valve which shall be single-seated, hydraulically-operated, diaphragm, globe-valve type. The typical valve seats shall be bronze (Note that the manufacturer recommends stainless steel seats when subjected to sustained high velocities through the valve). An indicator rod or flow tube shall be furnished as an integral part of the valve to show the position of the valve.

11.64.00 COMBINATION AIR VALVES

Air release valves shall be in conformance with AWWA C512 current standard, Air Release, Air/Vacuum and Combination Air Valves.

Single body combination air valves shall be the following type or PWU approved equal:
Note that inflow preventers shall be required on all vault installations:

ARI D-040

Combination air valves 2" and smaller shall have threaded NPT type inlets and outlets. For 3" and larger combination air valves, inlets shall be flanged.

Inflow preventers shall be the following type or CITY approved equal for combination air valves installed in vaults that could potentially flood with groundwater:

Val-Matic, Flood Safe

Inflow preventers shall be the following type or CITY approved equal for combination air valve installations that are not prone to groundwater flooding:

Wager Company, Model 2100

11.65.00 RESTRAINING SYSTEMS

11.65.01 Harness Rods

Harness rods and nuts shall be SAE type 304 stainless steel

11.65.02 Joint Restraint Devices

Joint restraint devices shall be manufactured of ductile iron conforming to ASTM A 536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to AWWA C111/A21.11-07, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings, and ANSI/AWWA C153/A21.53-06, Ductile Iron Compact Fittings. Twist-off nuts, sized the same as the tee-head bolts, shall be used to insure that the proper torque is applied to the bolts. In no case shall the twist-off bolts be torqued beyond the manufacturers' recommendations.

Mechanical joint restraint device shall have a working pressure of at least 350 psi for pipe sizes 4-16 inch and 250 psi for pipe sizes 18-48 inches, with a minimum safety factor of 2:1. Mechanical joint restraint devices shall be the following type:

EBAA Iron, Mega-lug, Series 1100 (DIP), Series 2000 (PVC)
Star, Series 3000, 3000S and 3000OS (DIP), Series 4000 (PVC)
Uniflange, Series 1400

Push on joint bell restraint harnesses shall have working pressures for PVC pipe of at least 200 psi for sizes 12 inches and smaller, 235 psi for pipe sizes 14 to 16 inches and working pressures for ductile iron pipe of at least 350 psi for pipe sizes up to 16 inches. Bell restraint harnesses shall be the following type: (bell restraint harnesses are not recommended for pipe sizes above 16 inches):

EBAA Iron, Mega-lug, Series 1700 (DIP), Series 1500, 1600 and 2800 (PVC)
Star Pipe Products, Series 3100P (for DIP only)
Smith-Blair, Series 165 (for PVC only)

11.66.00 CONCRETE REINFORCEMENT

All deformed reinforcing bars shall conform to ASTM Standards A-615, Grade 40 or 60, or ASTM Standard A-671, Grade 40 or 60. All welded wire steel fabric shall conform to ASTM Standard A-185.

11.67.00 BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assemblies shall conform to the requirements of AWWA C511 current standard, Reduced Pressure Principle Backflow Prevention Assembly. Backflow assemblies shall also meet the application requirements in Chapter 3 of these STANDARDS AND SPECIFICATIONS and Section 8-7-27 of the CITY CODE.

11.68.00 REPAIR CLAMPS

Repair clamps shall be entirely 18-8 Type 304 stainless steel including bands, lugs, nuts, and bolts. Gaskets shall be gridded virgin GPR compounded for water service and meeting the requirements of ASTM D 2000-90M 4AA607. Repair clamps shall be single or double panel as required to fit the pipe and shall have a minimum working pressure rating of 150 psi. Repair clamp length shall be greater than or equal to the host pipe diameter.

Repair clamps approved by the CITY shall be one of the following types:

PowerSeal, Model 3121AS or 3122AS
Ford, Style FS1 or FS2
Smith-Blair, Models 261 and 262
Romac, Style SS1 or SS2

TABLE OF CONTENTS

CHAPTER 12
ACCEPTANCE REQUIREMENTS

12.00.00 APPLICABILITY 12-1

12.01.00 ACCEPTANCE PROCEDURE 12-1
12.01.01 Written Request 12-1
12.01.02 Record Drawings 12-1
12.01.03 Certification of Stormwater Treatment Facilities 12-1
12.01.04 Preparation of Corrections List 12-2
12.01.05 Correction of Deficiencies 12-2
12.01.06 Written Acceptance 12-2
12.02.00 WARRANTY PERIOD 12-3
12.02.01 Duration 12-3
12.02.02 Maintenance Responsibility 12-3
12.02.03 Emergency Repairs 12-3
12.03.00 END OF WARRANTY PROCEDURE 12-3
12.03.01 Preparation of Corrections List 12-3
12.03.02 Correction of Deficiencies 12-4
12.03.03 Written Acknowledgment of End of Warranty 12-4
12.04.00 ACCEPTANCE/WARRANTY INSPECTION CRITERIA 12-4
12.04.01 General 12-4
12.04.02 Grading and Seeding 12-4
12.04.03 Water Systems 12-4
12.04.04 Sanitary Sewer System 12-5
12.04.05 Storm Sewer System 12-6
12.04.06 Concrete 12-6
12.04.07 Roadway 12-6
12.04.08 Signing 12-7
12.04.09 Striping 12-7
12.04.10 Street Lighting 12-7
12.04.11 Signals 12-7
12.04.12 Reclaimed Water System 12-8
12.04.13 Stormwater Treatment Facilities 12-8

CHAPTER 12
ACCEPTANCE REQUIREMENTS

12.00.00 APPLICABILITY

This chapter applies to all required PUBLIC IMPROVEMENTS and any stormwater treatment facilities. Before the CITY will assume ownership and maintenance responsibility for PUBLIC IMPROVEMENTS, the PUBLIC IMPROVEMENTS shall be formally accepted by the CITY ENGINEER. The OWNER is responsible for the proper installation of all improvements. Failure by the CITY's representatives to detect improper installations or defects during the construction of improvements or during subsequent inspections does not relieve the OWNER of the responsibility to correct such defects at a later date. There shall be no partial acceptances of PUBLIC IMPROVEMENTS.

12.01.00 ACCEPTANCE PROCEDURE

12.01.01 Written Request

At such time that the OWNER believes that the construction of all required PUBLIC IMPROVEMENTS and any stormwater treatment facilities have been completed, all improvements are accessible and visible for inspection and a written Release For Service (See Chapters 3 and 4) for water and sanitary sewer systems has been issued by the CITY's Engineering Division, a written request for ACCEPTANCE shall be submitted to the CITY ENGINEER.

12.01.02 Record Drawings

A complete set of "redlined" as-constructed drawings of the PUBLIC IMPROVEMENTS and any stormwater treatment facilities shall accompany the request for acceptance. If corrections to the improvements are noted during the acceptance inspection. The as-constructed drawings will be returned to the OWNER for revisions. The as-constructed drawings shall be of the entire plan set. Upon approval by the city, the OWNER will be required to submit a certified set of the as-construction drawings in digital PDF and DXF formats with the Professional Engineer registered in the State of Colorado's stamp and signature on each sheet.

12.01.03 Certification of Stormwater Treatment Facilities

A. Registered Land Surveyor: A land surveyor registered in the State of Colorado shall affirm the as-built stormwater treatment facility volumes and surface areas at the design depths, outlet structure sizes and elevations, storm sewer sizes and invert elevations at inlets, manholes, and discharge location, and representative open channel cross-sections, and dimensions of all structures. The certification shall include orifice plates, if any. Certification measurements shall not happen until landscape is established, or, with the approval of the CITY ENGINEER, the treatment facility base grade shall be constructed to six inches (6") below design elevations and certified without landscaping established.

B. Registered Professional Engineer: The Engineer of Record shall review the as-constructed stormwater treatment facilities and verify that any deviation of the as-built conditions from the construction drawings is within acceptable tolerances and are in accordance with

the design intent The Engineer of Record shall state that "I have reviewed the stormwater treatment facilities as-built information and to the best of my knowledge, belief, and opinion, the facilities appear to have been constructed in accordance with the design intent of the approved drainage report and construction drawings."

C. The DEVELOPER shall fully complete and submit an Operations and Maintenance Manual for stormwater treatment facilities to the CITY in accordance with the Phase III drainage report.

D. The DEVELOPER shall fully complete and submit the "Stormwater Detention and Infiltration Design Data Sheet" to the CITY in compliance with C.R.S §37-92-602(8). The CITY will input this data into the Colorado stormwater detention and infiltration facilities website.

12.01.04 Preparation of Corrections List

Upon receipt of the written request for ACCEPTANCE, certification of stormwater treatment facilities, and record drawings, the CITY INSPECTOR will schedule a final inspection of the work. The OWNER, or their representative will be invited to accompany the CITY's representative on all such inspections. The construction of PUBLIC IMPROVEMENTS and any stormwater treatment facilities will be inspected for conformance with the approved plans, the Official Development Plan, the Public Improvements Agreement, these STANDARDS AND SPECIFICATIONS, the CRITERIA and CITY CODE. If, due to excessive dirt or snow on streets, poor weather conditions, inaccessibility, or other reasons the inspection cannot be performed, the OWNER will be notified of the need to postpone these activities until the cause of the delay can be rectified. Deficiencies noted during the inspection will be compiled in a corrections list by the OWNER or their representative to be sent to the CITY INSPECTOR for review and approval.

12.01.05 Correction of Deficiencies

Correction list items shall be corrected within sixty (60) days of the date of the corrections list. If all of the noted deficiencies are not corrected within this time, the PUBLIC IMPROVEMENTS and any stormwater treatment facilities may be reinspected and any new defects may be added to the corrections list. Public improvements and any stormwater treatment facilities will not be accepted until all noted deficiencies are corrected within the proper time frame. The CITY INSPECTOR shall be notified before any corrective work commences and immediately upon the completion of the repairs.

12.01.06 Written Acceptance

Upon the completion of all items on the correction list and payment of all outstanding fees, reimbursements, and other items owed to the CITY, the CITY ENGINEER will issue a written ACCEPTANCE of the PUBLIC IMPROVEMENTS and any stormwater treatment facilities. The amount of the surety for the PUBLIC IMPROVEMENTS may then be reduced to fifteen percent (15%) of the original, estimated cost of the PUBLIC IMPROVEMENTS and any stormwater treatment facilities.

12.02.00 WARRANTY PERIOD

12.02.01 Duration

All PUBLIC IMPROVEMENTS and any stormwater treatment facilities shall be subject to a WARRANTY period of at least two (2) years after the date of the letter of ACCEPTANCE from the CITY ENGINEER.

12.02.02 Maintenance Responsibility

The OWNER shall be responsible for the maintenance of all PUBLIC IMPROVEMENTS and any stormwater treatment facilities during the WARRANTY period. The CITY ENGINEER will notify the OWNER of any maintenance that may be necessary during this time. Routine maintenance normally performed by the OWNER includes, but shall not be limited to, the cleaning of streets, patching of potholes, removal of blockages from water, storm and sanitary sewer facilities and any stormwater treatment facilities. Temporary erosion and sediment control BMPs shall be maintained according to the requirements of Chapter 2 of these STANDARDS AND SPECIFICATIONS. The cost of any routine maintenance not performed by the OWNER that must be performed by the CITY will be billed to the OWNER at cost plus fifteen percent (15%).

12.02.03 Emergency Repairs

In the event of a water main break, sanitary sewer main blockage, street or bridge failure, or other emergency that may occur during the WARRANTY period, it may become necessary for the CITY to undertake immediate repairs to the facilities and/or make the area safe to residents, pedestrians, or motorists. The CITY will attempt to contact the OWNER in the event of such emergency. If the OWNER cannot be contacted within two (2) hours of the initial incident report, or a CONTRACTOR repair crew cannot arrive onsite within six (6) hours, the CITY may proceed with such action as deemed necessary by the CITY ENGINEER, and the OWNER will be billed for all costs of these actions at cost plus fifteen percent (15%). The OWNER shall be responsible for final restoration of the affected site and will work with the CITY on making such restoration efforts.

12.03.00 END OF WARRANTY PROCEDURE

12.03.01 Preparation of Corrections List

At approximately twenty-one (21) months into the WARRANTY period, the CITY INSPECTOR will schedule and perform an inspection of the PUBLIC IMPROVEMENTS and any stormwater treatment facilities within the development. The OWNER will be invited to accompany the CITY INSPECTOR on all such inspections. The condition of the PUBLIC IMPROVEMENTS and any stormwater treatment facilities will be inspected for conformance with the PLANS, the Official Development Plan, the PUBLIC IMPROVEMENTS AGREEMENT, these STANDARDS AND SPECIFICATIONS, the CRITERIA and CITY CODE. If due to excessive dirt or snow on streets, poor weather conditions, inaccessibility, or other reasons the inspection cannot be performed, the OWNER will be notified of the need to postpone these activities until the cause of the delay can be rectified. Deficiencies noted during the inspection will be compiled in a corrections list by the OWNER to be sent to the CITY INSPECTOR for review and approval.

12.03.02 Correction of Deficiencies

WARRANTY correction list items should be corrected within sixty (60) calendar days of the date of the WARRANTY correction list, and all corrections must be completed no later than ten (10) working days prior to the scheduled end of the WARRANTY. If all of the noted deficiencies are not corrected within this time, the PUBLIC IMPROVEMENTS and any stormwater treatment facilities may be reinspected, a revised correction list may be issued, and the end of the WARRANTY may be adjusted at the discretion of the CITY ENGINEER to allow ample time for the completion of the corrections. The end of the WARRANTY will not be acknowledged until all noted deficiencies are corrected within the proper time frame. The CITY INSPECTOR shall be notified before any corrective work commences and immediately upon the completion of the repairs.

12.03.03 Written Acknowledgment of End of Warranty

Upon completion of the correction of all deficiencies noted in the WARRANTY correction list, the CITY ENGINEER will issue a written acknowledgment of the end of the WARRANTY for the PUBLIC IMPROVEMENTS and any stormwater treatment facilities. SURETY for PUBLIC IMPROVEMENTS and any stormwater treatment facilities may be released in its entirety at this time.

12.04.00 ACCEPTANCE/WARRANTY INSPECTION CRITERIA

12.04.01 General

All PUBLIC IMPROVEMENTS and any stormwater treatment facilities shall be installed in conformance with the PLANS, the Official Development Plan, IMPROVEMENTS AGREEMENT, these STANDARDS AND SPECIFICATIONS and CITY CODE. The COMMUNITY DEVELOPMENT DIRECTOR shall be the final authority in the determination of defects and required corrections to PUBLIC IMPROVEMENTS and any stormwater treatment facilities.

12.04.02 Grading and Seeding

Finished grades shall be in conformance with the approved plans and the Official Development Plan. Unless otherwise approved, no slopes shall exceed a grade of four (horizontal) to one (vertical) (4:1). Seeding shall be performed and grass shall be established in conformance with Chapter 2 of these STANDARDS AND SPECIFICATIONS.

12.04.03 Water Systems

The required inspection and testing of water mains and appurtenances that shall be performed before systems can be released for service is outlined in Chapter 3 of these STANDARDS AND SPECIFICATIONS. At the time of ACCEPTANCE and WARRANTY inspections of all PUBLIC IMPROVEMENTS and PRIVATE IMPROVEMENTS, additional aspects of water system construction that shall be inspected include, but shall not be limited to, the following:

(A) All valves, blow-off installations, and fire hydrants shall be operable.

(B) Valve box risers shall be vertical and shall be adjusted to within one-eighth inch (1/8") below grade in paved areas or one inch (1") above grade in landscaped areas.

(C) Valve operating nuts shall be accessible with a six-foot (6') valve key with between eighteen inches (18") and four feet (4') of clearance between the handle of the key and finished grade.

(D) Fire hydrants shall be vertical and shall be adjusted to a minimum of eighteen inches (18") from the center of the nozzle to finished grade. Extensions shall not be allowed.

(E) A minimum of five feet (5') of clearance for operation shall be provided around all fire hydrants and water valve risers.

(F) Manhole rims and covers for water valve vaults shall be adjusted to within one-eighth inch (1/8") below grade in paved areas or one inch (1") above a concrete collar in landscaped areas. Bollards may be required by the CITY ENGINEER.

(G) The construction and operation of any required pumping systems shall be in conformance with the specifications issued and approved for that specific installation.

(H) All vaults and meter pits shall be free of construction debris, dirt, trash, and other foreign material. All steps shall be properly installed, spaced and aligned.

12.04.04 <u>Sanitary Sewer System</u>

The required inspection and testing of sanitary sewer mains and appurtenances that shall be performed before systems can be placed into service is outlined in Chapter 4 of these STANDARDS AND SPECIFICATIONS. At the time of ACCEPTANCE and WARRANTY inspections of all PUBLIC IMPROVEMENTS, additional aspects of sanitary sewer system construction that shall be inspected include, but shall not be limited to, the following:

(A) All mains and manholes shall be free of construction debris, dirt, trash, and other foreign material.

(B) The CITY's TV inspection of all sanitary sewer mains shall be completed prior to the ACCEPTANCE of public improvements. All lines shall be jet-cleaned prior to TV inspection.

(C) Manhole rims and covers shall be adjusted to within one-eighth inch (1/8") below grade in paved areas or one inch (1") above grade in landscaped areas.

(D) Grade adjustment rings shall be properly installed and spaced in accordance with Chapter 4. The maximum depth of the adjustment rings shall be twelve inches (12”). If manholes are located in paved areas, the maximum depth from the top of cone to street grade shall be eighteen inches (18”). If manholes are located in field installations, the ring and cover shall be twelve to eighteen inches (12” – 18”) above final grade.

(E) Manhole steps shall be properly installed, spaced, and aligned.

12.04.05 Storm Sewer System

The required inspection and testing of storm sewer mains and appurtenances that shall be performed are outlined in Chapter 5 of these STANDARDS AND SPECIFICATIONS. At the times of ACCEPTANCE and WARRANTY inspections of all PUBLIC IMPROVEMENTS, additional aspects of storm sewer system construction that shall be inspected include, but shall not be limited to, the following;

(A) All pipes and manholes shall be free of construction debris, dirt, trash, and other foreign material.

(B) Manhole rims and covers shall be adjusted to within one-eighth inch (1/8") below grade in paved areas or one inch (1") above grade in landscaped areas.

(C) Manhole steps shall be properly installed, spaced and aligned.

(D) Inlets shall be constructed flush with adjoining pavement, sidewalk and/or curb and gutter.

12.04.06 Concrete

At the time of ACCEPTANCE and WARRANTY inspection of all PUBLIC IMPROVEMENTS the aspects of concrete construction that shall be inspected include, but shall not be limited to the following:

(A) Breakage or cracking greater than 1/32" at areas other than construction joints.

(B) Ponding of any size.

(C) Settlement affecting drainage, pedestrian or traffic safety.

(D) Surface spalling or deterioration.

(E) Any longitudinal cracking.

12.04.07 Roadway

At the time of ACCEPTANCE and WARRANTY inspection of all PUBLIC IMPROVEMENTS, the aspects of roadway construction that shall be inspected include, but shall not be limited to, the following:

(A) Breakage or cracking greater than 1/8". All breakage or cracks equal to or greater than 1/8" shall be removed and replaced. The distance of removal and replacement shall be determined by the CITY INSPECTOR. All breakage or cracks less than 1/8" shall be grinded and sealed. This shall be completed prior to ACCEPTANCE.

(B) Ponding of any size.

(C) Settlement affecting drainage, pedestrian or traffic safety.

(D) Surface segregation of fines or aggregate

(E) Hazardous conditions

(F) Alligator cracking

(G) Improper grade or inverted crown.

12.04.08 Signing

At the time of ACCEPTANCE and WARRANTY inspection of all PUBLIC IMPROVEMENTS, the aspects of sign construction that shall be inspected include, but shall not be limited to, the following:

Unless otherwise noted on the PLANS, all signs shall be installed per PLANS and conform to these STANDARDS AND SPECIFICATIONS. The CONTRACTOR shall notify the CITY of substantial completion so staff can complete the inspection process and provide a list of corrections needed to the CONTRACTOR. Once the project has been accepted then the signage shall enter a two (2) year WARRANTY.

12.04.09 Striping

At the time of ACCEPTANCE and WARRANTY inspection of all PUBLIC IMPROVEMENTS, the aspects of striping construction that shall be inspected include, but shall not be limited to, the following:

Unless otherwise noted on the PLANS, all traffic striping shall be installed per PLANS and conform to these STANDARDS AND SPECIFICATIONS. The CONTRACTOR shall notify the CITY of substantial completion so staff can complete the inspection process and provide a list of corrections needed to the CONTRACTOR. Once the project has been accepted then the striping shall enter a two (2) year WARRANTY.

12.04.10 Street Lighting

At the time of ACCEPTANCE and WARRANTY inspection of all PUBLIC IMPROVEMENTS, the aspects of street lighting construction that shall be inspected include, but shall not be limited to, the following:

Unless otherwise noted on the PLANS, all street lighting shall be installed per PLANS and conform to these STANDARDS AND SPECIFICATIONS. The CONTRACTOR shall notify the CITY of substantial completion so staff can complete the inspection process and provide a list of corrections back to the CONTRACTOR. Once the project has been accepted then the street lighting system shall enter a two (2) year WARRANTY.

12.04.11 Signals

At the time of ACCEPTANCE and WARRANTY inspection of all PUBLIC IMPROVEMENTS, the aspects of traffic signal construction that shall be inspected include, but shall not be limited to, the following:

Unless otherwise noted on the PLANS, all traffic signals shall be installed per PLANS and conform to these STANDARDS AND SPECIFICATIONS. The CONTRACTOR shall notify

the CITY of substantial completion so staff can complete the inspection process and provide a list of corrections needed to the CONTRACTOR. Once the project has been accepted then the traffic signal shall enter a two (2) year WARRANTY.

12.04.12 Reclaimed Water System

The required inspection and testing of reclaimed water mains and appurtenances that shall be performed before systems can be released for service is outlined in Chapter 11 of these STANDARDS AND SPECIFICATIONS. At the time of ACCEPTANCE and WARRANTY inspections of all PUBLIC IMPROVEMENTS and PRIVATE IMPROVEMENTS, additional aspects of the reclaimed water system construction that shall be inspected include, but shall not be limited to, the following:

(A) All valves, blow-off installations, and fire hydrants shall be operable.

(B) Valve box risers shall be vertical and shall be adjusted to within one-eighth inch (1/8") below grade in paved areas or one inch (1") above grade in landscaped areas.

(C) Valve operating nuts shall be accessible with a six-foot (6') valve key with between eighteen inches (18") and four feet (4') of clearance between the handle of the key and finished grade.

(D) A minimum of five feet (5') of clearance for operation shall be provided around all water valve risers.

(E) Manhole rims and covers for water valve vaults shall be adjusted to within one-eighth inch (1/8") below grade in paved areas or one inch (1") above a concrete collar in landscaped areas. Bollards may be required by the CITY ENGINEER.

(F) All vaults and meter pits shall be free of construction debris, dirt, trash, and other foreign material. All steps shall be properly installed, spaced and aligned.

(G) A valid Notice of Authorization from the State of Colorado is in place for the reclaimed water system.

12.04.13 Stormwater Treatment Facilities

At the time of ACCEPTANCE and WARRANTY inspections of all PUBLIC IMPROVEMENTS and PRIVATE IMPROVEMENTS, additional aspects of stormwater treatment facilities construction that shall be inspected include, but shall not be limited to, the following:

(A) Prefabricated components will be installed and tested per manufacturer's specifications.

(B) Systems with infiltration processes will be field tested with a flow test.

(C) The CITY ENGINEER will verify all requirements of these STANDARDS AND SPECIFICATIONS have been satisfied.