FORWARD

The Cedar City Engineering Department has prepared the following edition of the

CEDAR CITY
ENGINEERING STANDARDS

These standards shall be used for all work located within public streets, rights-of-way, and easements within Cedar City.

Nothing in these standards shall be construed to prohibit the construction of higher type improvements, as approved by the City Engineer.

These Standards meet with the full approval of the City Engineer, dated February 23, 2022.

Jonathan Stathis, P.E.
Cedar City Corporation
City Engineer

These Standards were approved by the City Council of Cedar City by Resolution dated January 25, 1995, with revisions approved as follows:

March 27, 1996
March 1, 1997
March 18, 1998
June 9, 1999
October 18, 2000
June 12, 2002
September 8, 2004
July 12, 2006
August 27, 2008
February 9, 2011
September 19, 2012
September 19, 2014
August 24, 2016
September 18, 2019
July 28, 2021
February 23, 2022

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SECTION 2
GENERAL IMPROVEMENT REQUIREMENTS

2.1 GENERAL: This section defines the general requirements for public improvements within Cedar City.

The improvements shall include all improvements of a public need, including, but not limited to streets, water, sewer, and drainage. Required improvements shall extend from the nearest acceptable point of existing improvements. Layout must provide for future extension to adjacent properties and shall be compatible with appropriate City master plans. All water lines shall be installed to the boundary lines of the development. Required geotechnical investigation recommendations shall be followed.

2.2 DEFINITIONS:

2.2.1 CONTRACTOR shall refer to the person or persons actually performing the construction work.

2.2.2 CUSTOMER shall refer to any individual requiring utility services (power, water or sewer).

2.2.3 DEVELOPER shall refer to the contractor, property owner or agent as applicable.

2.2.4 CITY ENGINEER shall refer to the Cedar City Engineer or an authorized representative.

2.2.5 OWNER shall refer to subdividers, developers, or others responsible for constructing improvements or developments on property within Cedar City.

2.2.6 SEWER LATERAL shall refer to any sanitary sewer pipe which runs from the outside of any building to the sewer main line.

2.2.7 SEWER MAIN shall refer to any sanitary sewer line that is eight-inches in diameter or greater.

2.2.8 SEWER OUTFALL LINE shall refer to any sanitary sewer line that is 15-inch diameter or greater and carries major sectors of the community or region having trunk lines as its tributaries.

2.2.9 WATER LATERAL shall refer to any domestic service water pipe, including meter box or vault, meter setter, valving and lid.

2.2.10 WATER DISTRIBUTION MAIN shall refer to any domestic water line that is 6-inch to 12-inch diameter.

2.2.11 WATER TRANSMISSION MAIN shall refer to any domestic water line that is larger than 12-inches in diameter.

2.2.12 DRAINAGE CONTROL PLAN AND REPORT (DCPR) shall refer to a drainage report that is required to be submitted for all development projects. The DCPR will be reviewed by the City Engineering Department to ensure compliance with City Engineering Standards for drainage improvements. The DCPR is required to be stamped and signed by a licensed professional engineer in the state of Utah. The requirements for DCPR are listed in Chapter 3 of these Engineering Standards.

2.3 CONSTRUCTION DRAWINGS: Complete and detailed construction plans and drawings of improvements shall be submitted to the City Engineer. No construction shall be started until plans have been checked and approved by the City Engineer, and other appropriate City officials.

The following instructions are for the purpose of standardizing the preparation of drawings to obtain uniformity in appearance, clarity, size and style:

One set of construction plans shall be submitted to the City Engineer for checking and returned to the Owner/Contractor for correction. When all corrections have been made and the set approved, four approved sets shall be provided to the City Engineer.

The plans and designs shall meet the standards defined in the Specifications and Drawings hereinafter outlined.

All drawings and/or prints shall be clear and legible and conform to good engineering and professional drafting room practice. Generally, the size of drawings shall be three sets of 24" by 36" and one set of 11" X 17".

The developer shall also provide all as-built drawings in Auto Cad format by Electronic disk or e-mail with a .dxf or .dwg file format upon completion of the project.

2.3.1 GENERAL: The following shall be included on all drawings:

I. North arrow.

II. Scale (1" = 100' Minimum).

III. Consistent letter, stationing and numbering that reads left to right on the page and does not overlap with other text or leaders.

IV. Title block, located along the right side of each sheet to include:

A. Project title;

B. Date drawn;

C. Engineer/Surveying Company Name, Address, Phone # and Fax #;

D. Professional Engineers stamp box (licensed in the State of Utah) with Signature and Date;

E. Internal checker's initials box;

F. The section, township and range location of the project;

G. Sheet number box.

V. All drawing features on that drawing shall be labeled using a tag and construction note format.

VI. All required coordinates on that drawing shall be shown using a tag and table format, using a unique tag # for each different kind of feature- i.e. S.M.H. #1, GV #1 for Sewer Manhole and Gate Valves respectively.

2.3.2 TITLE SHEET THAT INCLUDES:

I. Project Name

II. Vicinity Map

III . Project Concept Plan

IV. Drawing Index

V. Public Works Approval Certificate

VI. City Engineers Approval Certificate

VII. Utility Contacts Per Checklist

2.3.3 AN OVERALL IMPROVEMENT PLAN SHEET OR PRELIMINARY SUBDIVISION PLAN that includes the following and other information as required by the checklist:

I. Survey control monument locations including sectional tie bearing and lengths, basis of bearing and elevation datum – NAVD 27.

II. Street layout including name and or numbers, width and fillets.

III. Water system layout including pipe size, valving, fire hydrants, PRV's and

air vacs.

IV. Sewer system layout including pipe size, and manholes.

V. Drainage system layout including pipe size, manholes, curb inlets and outlets, channels, detention basins and irrigation ditches.

VI. Street light layout.

2.3.4 PLAN/PROFILE SHEETS that include the following on the same plan/profile sheets and other information as required by the checklist:

I. Proposed streets including master planned streets, names and/or numbers, curve data in tag and table format for each curve on the sheet, vertical curve information, existing street transitions, future street transitions, signs, slopes, centerline bearings and lengths, road stations and elevations on NAVD 27 datum, cul-de-sacs, street width, curb-gutter, sidewalk locations & elevations, handicap ramps, cross gutters, driveways, centerline monuments, asphalt tapers, conduit crossings, street lights, typical street cross sections from right-of-way line to right-of-way line, showing type of curb, sidewalk and pavement section.

II. Proposed water lines including master planned water mains, sizes, material, valves, fire hydrants, blow-offs, PRV stations and water laterals.

III. Proposed sewer lines, including master planned sewer lines, sizes, material, and slopes: manhole sizes, locations, elevation of rim and invert in and invert out; sewer lateral locations, sizes and material; pressure sewer lines and lift stations.

IV. Proposed storm drain system including master planned storm drains, culverts, channels, size, slope, material; manhole sizes, locations, elevation on rim and inverts; curb inlets, curb outlets, end sections, detention basins and irrigation ditches.

2.3.5 DETAIL SHEETS: Each set of plans shall be accompanied by separate sheets of details that will be constructed on the project. Detail sheets shall include all current Cedar City Standard Engineering details that apply to the project plus and special details required for the project. A testing schedule will also be required on the detail sheets showing all required quality control tests in the format shown on the standard details

2.3.6 MISCELLANEOUS DRAWING SHEETS: The following miscellaneous drawing sheets shall be required if requested by the City Engineer:

I. Finished street cross sections from 20’ outside each right-of-way line shall be

shown at intervals not exceeding 200 feet on all streets.

II. A grading plan for the project showing finished pad and adjacent TBC elevations.

2.4 INSPECTION, TESTING AND QUALITY CONTROL. All construction work involving the installation of improvements in Cedar City shall be subject to City inspection and testing as outlined in the quality control section of each specification.

2.4.1 REQUESTS FOR INSPECTION: Requests for inspections shall be made to the City Engineer or Inspector by the person responsible for the construction. Notice shall be given 24-hours in advance of the starting of work. Any work to be backfilled or covered shall not be backfilled or covered prior to inspection.

2.4.2 CONSTRUCTION COMPLETION INSPECTION. A final inspection shall be made by the City Engineer, or a representative upon receipt of a request by the owner after all construction work is completed. Any faulty or defective work shall be corrected by the persons responsible for the work, within a period of thirty (30) days from the date of the City Engineer's Inspection Report defining the faulty or defective work.

2.4.3 QUALITY CONTROL TESTING. Material testing shall be conducted by an independent laboratory, approved by the City Engineer, at the owner's expense. All testing shall comply with current ASTM, AASHTO, AWWA or Public Drinking Water Regulation standards and shall meet the minimum testing requirements as outlined in the specifications. Personnel performing tests shall have the appropriate certifications to perform such tests. The cost of any and all re-testing required to bring materials into specification shall be borne by the owner or contractor. The time and locations of all tests shall be approved by the City Engineer's office. If determined necessary by the City Engineer or a representative, additional testing can be required.

2.4.4 TEST REPORTS. Written test results will be required for review by the City Engineer after each portion of the work (i.e. pipeline construction, earthwork, curb, gutter and sidewalk, roadway construction).

A final certified grading report submitted and stamped by a professional engineer registered in the State of Utah will be required from the developer=s testing firm upon completion of the project. This report will include the following:

1. Title Sheet to include:
   a) Project Name
   b) Testing company Name, Address, Phone #, Fax #
   c) Date
2. Tab index for each tabbed section of items 3 through 6.
3. Certification letter signed/stamped, certifying all testing done per City Standards, materials with failed tests were corrected, opinion that project conforms to the City Standards as far as indicated by testing.

4. Testing summary – patterned after the testing schedule on the plans with additional columns for number of tests performed, number of tests passing, number of tests failing, comments.
5. Failed test/Retest summary including:
   a) Original Test ID #
   b) Retest ID #
   c) Improvement
   d) Location
   e) Retest results
6. All individual tests reports in the order of the testing schedule.

2.5 AS-BUILT DRAWINGS. Before final inspection, the developer shall provide a complete set of as-built drawings that includes all items specified in Section 2.3 Construction Drawings. The as-built drawings shall show all improvement dimensions as they were constructed in the field. The as-built drawings shall be submitted on 24" by 36" Mylar sheets and in AutoCAD .dwg format and PDF format. No bond retainer shall be released until as-built drawings are received.

2.6 GUARANTEE OF WORK. The owner shall warrant and guarantee that the improvements provided for hereunder, and every part thereof, will remain in good condition for a period of one year after the date of the acceptance of the project by the City. The owner shall make all repairs to and maintain the improvements and every part thereof in good condition during the specified time at no cost to the City.

The determination for the necessity of repairs and maintenance of the work shall rest with the City Engineer. Such decision upon the matter shall be final and binding upon the owner. The guarantee hereby stipulated shall extend to and include, but shall not be limited to, the entire road base, all pipes, joints, valves, manholes, backfill and compaction as well as the working surface, curbs, gutters, sidewalks, and other accessories that shall be constructed by the owner. Whenever, in the judgment of the City Engineer, said work shall be in need of repairs, maintenance, or rebuilding, written notice shall be served upon the owner and thereupon the owner shall undertake and complete such repairs, maintenance or rebuilding. If the owner fails to do so within thirty days from the date of the service of such notice, the City Engineer shall have such repairs made, and the cost of such repairs shall be paid by the owner together with 25 percent of the cost of the repairs in addition thereto, as stipulated damages for such failure on the part of the developer to make the repairs. Any omission on the part of the Engineer to condemn defective work or material at the time of construction shall not be deemed an acceptance. The contractor and/or owner will be required to correct defective work or material at any time before final acceptance and within one year thereafter.

2.7 BARRICADES AND WARNING SIGNS. The Contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs, and other traffic control devices. All necessary precautions shall be taken to protect the work and to safeguard the public. Streets closed to traffic shall be protected by effective barricades, and obstructions shall be illuminated during hours of darkness. Suitable warning signs shall be provided to control and direct traffic properly. All traffic control operations and signing shall be performed in accordance with the instructions outlined in the "Manual on Uniform Traffic Control Devices", latest edition. A traffic

control plan will be required for submittal and approval on each project.

2.8 SURVEY MONUMENTS. Standard City survey control monuments (as shown in the standard drawings of these standards) shall be installed in all streets to be dedicated for public use. All survey control monuments shall be installed in strategic locations (as determined by the City Engineer) so as to insure adequate survey control required for subsequent resurvey in the area.

2.9 IMPROVEMENT SEQUENCE. City improvements shall be installed in the following sequence, unless otherwise directed by the City Engineer.

1. Rough grading
2. Sanitary Sewer
3. Culinary Water
4. Storm Sewer
5. Private Utilities & Conduits (In Right-of-Way)
6. Sub Base
7. Curb and Gutter
8. Road Base
9. Asphalt
10. Private Utilities (In Easement)
11. Sidewalks
12. Manholes and Valve Grades
13. Survey Monument
14. Street Signs
15. Street Lights
16. Clean-up

(Private Utilities are Electric, Natural Gas, Telecommunications, and Cable T.V. Services)

Contractors and developers shall ensure that all improvement items previous to item #9 (asphalt) are installed before the asphalt. Prior to asphalt installation, developers will provide to the City Engineer a sign-off sheet signed by the electric, telephone, natural gas and cable T.V. utilities verifying their utility or appropriate conduits have been installed. The Development's Engineer and material testing firm shall also sign-off and stamp verifying all City required underground improvements (i.e. sewer, water, storm drains, etc.) have been installed and tested according to the approved construction drawings. **No road breaking permits will be issued on new City streets for 2 years from the date the street was accepted by the City.**

SECTION 3

DESIGN STANDARDS

3.1 GENERAL. This section defines design requirements for public improvements within the City of Cedar City. It is not the intent of these standards to restrict professional judgment, but rather to serve as a guide and to establish consistency and the minimum requirements in design.

3.2 STREET DESIGN. All streets within Cedar City shall be designed structurally to conform to Section 4.3, "Roadway Construction", of these standards. Streets shall conform to City standards for location, grades, centerline curve radii, right-of-way, pavement, curb, gutter and sidewalk dimensions, and volumes as shown in Table 3.1.

TABLE 3.1
STREET DESIGN STANDARDS

STREET TYPE (Location)	DESIGN VOLUME/ Level of Service (Vehicles per day in each direction)	DESIGN TRAFFIC INDEX	MAX. GRADE (4)	MIN. C.L. RADIUS	MIN. INTER-SECTION RIGHT – OF – WAY RADIUS	RIGHT OF WAY Width (feet) (6)	PAVE-MENT Width (feet)	SIDE-WALK (1) (3) Width (feet)	CURB & GUTTER TYPE (2)
LOCAL	800/D	5.5	15	100	15	45	30	4	A
COLLECTOR	1600/C	5.5	12	200	15	55	40	4	A
MAJOR COLLECTOR (1/4 sec. line)	3200/C	6	12	300	20	66	51	4	A
ARTERIAL (Section line)	>3200/B	6.5	10	500	30	75	58	5	A
MAJOR ARTERIAL (Township/ Range lines)	-	7.5	10	600	35	100	81	6	A

Notes for Table 3.1:

(1) Streets shall not have a longitudinal grade of less than 0.40% unless adequate alternative street drainage is provided.

(2) Areas of high water flow may require larger curb and gutter capacity than shown.

(3) Sidewalk in areas of high pedestrian traffic shall require greater width as determined by the City Engineer.

(4) Road grades greater than 12% up to and including 15% shall be no longer than 100 feet. Grades greater than 10% up to and including 12% shall be no longer than 500 feet. Any road grade greater than 10% up to and including 15% shall have at least 200 feet of road length on each end with no grade greater than 10%.

(5) Required street widths to be determined by projected traffic volumes. Minimum street width will be 45-feet in residential areas and 55-feet in Commercial and Industrial areas.

(6) For right-of-way width for Road Section with Trails see Standard Drawing R4A.

3.2.1 GEOMETRIC DESIGN. Streets shall be designed to provide adequate stopping and sight distance, degree of curve, and super-elevation in accordance with The American Association of State Highway and Transportation Officials (AASHTO). Vertical curves shall be provided in all changes in grade where the algebraic difference is 1% or greater.

3.2.2 INTERSECTIONS. Street intersection centerline offsets shall be not less than 150 feet. Street intersection horizontal alignment shall be as near to 90 degrees as possible ± 5E maximum. The grade of an intersecting street shall not exceed 4% and have a 50-foot long tangent minimum.

3.2.3 CUL-DE-SACS. Cul-de-sac streets shall not exceed 500 feet in length from edge of cross street to center of cul-de-sac, and the turn-around radius (at property line) shall not be less than fifty feet for residential areas and sixty feet for commercial and industrial areas. Paved cul-de-sacs with curb and gutter and sidewalk will be required on the permanent end of any City street. A fire hydrant will be required at the end of each Cul-de-sac.

3.2.4 STREET ACCESS. The number of access points onto City streets shall be kept to a minimum. The following information shall apply when designing street access for all developments.

I. Direct access will not be allowed for parking, loading or driveway areas that require backing maneuvers onto major collector or arterial streets.

II. Residential and commercial developments will be required to provide at least two improved accesses to the development when the combination of dwelling units and commercial lots exceeds 80. The accesses shall be proper widths to accommodate the calculated traffic volumes when the area is fully developed. Design volumes for various street widths are shown in Table 3.1. Projected traffic volumes shall be calculated at the rate of 10 vehicles per day each direction per potential dwelling unit.

III. No covered driveways will be allowed unless approved by the City Engineer.

IV. Street access for all developments shall also comply with City Ordinance 0928-11-1 adopting the Iron County Rural Planning Organization Access Management Standards.

3.2.5 CURB SIDE MAIL BOXES. Curb side mail boxes shall be installed according to the standard drawings.

3.2.6 SIGNS. All signs required in City streets shall be installed by the developer according to the standard drawings.

3.2.7 TEMPORARY STREETS. When streets are installed through undeveloped areas where water and sewer service lateral locations cannot be determined; a temporary street section as shown on standard drawing R5 can be installed when approved by the City Planning Commission. This temporary street section shall be removed and replaced with the required street section when the area is developed. Temporary street sections shall only be used for the following: (1) master-planned streets that are not part of a development; and (2) the required second access for the development.

3.2.8 ACCESS CONTROL. No driveways or other access points will be allowed within 150 feet of the intersection of two arterial streets or the intersection of an arterial street with a major collector measured from the right-of-way line to the leading edge of the driveway. Driveways and/or other access points along all arterial streets shall be no closer than 100 feet measured between the nearest edges of the driveways.

3.2.9 ASPHALT TAPERS. Where the width of road asphalt narrows, an asphalt taper shall be installed according to Standard Detail R10.

3.3 DRAINAGE SYSTEM DESIGN. All subdivisions in Cedar City shall be designed to accommodate rainfall and underground spring runoff in systems separate and independent from the sanitary sewer system. Hydrology studies may be required as part of the design.

3.3.1. SPRING CONTROL. When in the determination of the City Engineer spring control is necessary, the owner shall provide an adequate pipe system to eliminate the nuisance of overland flow.

3.3.2. FLOOD CONTROL AND DRAINAGE SYSTEM IMPROVEMENTS. Prior to altering the existing surface characteristics, developers shall consult with the City Engineer and submit a Drainage Control Plan and Report (DCPR) in accordance with Section 2.2.12 of these Engineering Standards and as described in this section. No development shall occur until the DCPR is approved by the City Engineer. A flood control and storm water drainage system shall be designed and approved as part of the construction plans. Floodwater and storm drainage water may be conveyed in pipes, major washes, designated floodway easements, or dedicated city streets. Where open ditches or canals exist within or adjoining a residential or commercial subdivision or residential or commercial project requiring a building permit, the developer/owner may be required to pipe the channel or ditch or make other improvements to property belonging to a third-party, canal or irrigation company. Under such circumstances, developers shall coordinate with the canal or irrigation company to accommodate safety or flood control needs of the project. Any proposed use or modification of canal or irrigation company property for such purposes will require canal or irrigation company approval. In order to provide for the public safety and protect against flooding, the City Engineer shall review any proposed modifications to or use of irrigation or canal company property. Review and approval of flood control and/or storm water drainage measures which propose the use or modification of irrigation or canal company property or facilities by the City will be limited to protection of public safety. Completion of canal or irrigation channel improvements, and coordination with a canal or irrigation company shall

not unreasonably delay acceptance of the project's public improvements, issuance of building permits, or issuance of certificates of occupancy as long as the City Engineer determines that public safety issues have been adequately addressed.

Design of flood control systems shall meet the following criteria:

I. A flood of 100-year return frequency and 3-hour duration shall be conveyed within the limits of street right-of-way or easements when used for flood control purposes. NOAA precipitation data corresponding to the development location must be used in all drainage calculations.

II. All occupied buildings shall be constructed outside floodway limits and above the flood elevation indicated on the FEMA Flood Insurance Rating map.

III. Where an underground pipe system is required, it shall be designed to carry a 10-year return frequency flood with 3-hour duration or the excess of the 100-year flood with 3-hour duration that the street cannot contain, whichever is greater. Major hydraulic structures shall be designed to carry a 100-year return frequency flood with 3-hour duration. Detention and retention basins shall be designed for a 100-year, 24-hour storm event.

IV. Streets may be inverted to carry floodwater only with sufficient justification and upon approval of the City Engineer.

V. When designing flood systems, the Engineer shall give proper consideration to adjacent properties. The drainage basin upstream shall be assumed fully developed to conform to the current land use master plan. The impact of said runoff on down-stream properties shall also be considered in the design, including acquisition of easements or agreements when necessary. On site retention may be required.

Drainage Control Report and Plan is required as follows:

Prior to approval of construction drawings for new development, a Drainage Control Plan and Report shall be prepared by a licensed professional civil engineer registered in the State of Utah.

DRAINAGE CONTROL PLAN AND REPORT:

The report portion of the Drainage Control Plan and Report shall contain the following:

1. Title page showing project name, date, preparers name, seal, and signature.

2. Description of property, area, existing site conditions including all existing drainage facilities such as ditches, canals, washes, structures, etc.

3. Description of off-site drainage upstream and downstream.

4. Description of on-site drainage.

5. Description of master-planned drainage improvements and how development conforms with the City's Storm Drain Master Plan.

6. Description of FEMA floodplain, if applicable.

7. Description of other drainage studies that affect the site.

8. Description of proposed drainage facilities.

9. Description of compliance with applicable flood control requirements and FEMA requirements, if applicable.

10. Description of runoff computations.

11. Description of drainage facility design computations.

12. Description of all easements and rights-of-way required.

13. Description of FEMA floodway and floodplain calculations, if applicable.

14. Description of irrigation company ditches located in or near the development. Description of impact to existing irrigation company ditches. Information regarding any proposed modifications to existing irrigation company ditches, including the discharge of drainage from the development into an irrigation company ditch. The irrigation company must be notified on any modifications and written approval must be obtained from the irrigation company for any proposed modifications.

15. Conclusions stating compliance with drainage requirements and opinion of effectiveness of proposed drainage facilities and accuracy of calculations.

16. Appendices showing all applicable reference information.

A drainage plan drawing on a separate 24-inch by 36-inch sheet(s) shall be submitted with the Drainage Control Plan and Report showing the following information:

1. Existing and proposed property lines.

2. Existing and proposed streets, easements, and rights-of-way.

3. Existing drainage facilities.

4. FEMA floodplain, floodway, and meander boundaries.

5. Drainage basin boundaries and subbasin boundaries.

6. Existing flow patterns and paths.

7. Proposed flow patterns and paths.

8. Location of proposed drainage facilities.

9. Details of proposed drainage facilities.

10. Location of drainage easements required.

11. Scale, north arrow, legend, title block showing project name, date, preparers name, seal, and signature.

CONCEPTUAL DRAINAGE CONTROL PLAN AND REPORT

Prior to Planning Commission, or at the time of review of Zone Changes, Vicinity Plans, or Conditional Use Permits, the City Engineer may require a Conceptual Drainage Control Plan and Report containing the following information:

1. General description of the development.

2. General description of existing drainage facilities.

3. General description of property, area, existing site conditions including all existing drainage facilities such as ditches, canals, washes, structures, and any proposed modifications to drainage facilities. General description of irrigation company ditches located on or near the development site.

4. General description of off-site drainage upstream and downstream and known drainage problems.

5. General description of on-site drainage and potential drainage problems.

6. General description of master-planned drainage facilities and proposed drainage measures and how development conforms to the City's Storm Drain Master Plan.

7. Existing FEMA floodplain boundaries, if applicable.

8. Exhibit showing existing and proposed drainage improvements.

9. Preliminary drainage calculations if required by the City Engineer.

3.3.3. CURB & GUTTER. Minimum curb and gutter grade shall be 0.40% (0.40 foot elevation difference in 100 feet of curb length).

3.3.4. MINIMUM PIPE SIZE. Minimum culvert size shall be 18-inch diameter, except for culvert crossings at driveways as shown on Detail R4C where a 15-inch diameter is allowed. The minimum storm drain size shall be 18-inch diameter.

3.3.5 MINUMUM PIPE SLOPE: Culverts and storm drain shall be sloped sufficient to maintain 3 feet per second flow velocity flowing half full, or a 0.30% minimum slope whatever is greater.

3.3.6. STORM DRAIN MANHOLES. Manholes shall be installed at all changes in grade, direction, and size. Distances between manholes and/or in-line inlet boxes shall be no greater than 500 feet apart. All manholes shall be accessible to maintenance vehicles, and all easements shall provide at least 20 feet of unobstructed width. Floor troughs shall be furnished for all pipes entering manholes, and shall be at least as deep as the full diameter of the pipe in the manholes.

When pipes join in a manhole, the pipe flow line elevation of the outlet pipe shall be 0.10 feet lower than the inlet pipe.

All manholes shall conform to the detailed dimensions, construction details and materials as shown in the standard drawings. Manholes shall also conform to the conditions as detailed in Section 3, of these standards.

3.4 SANITARY SEWER DESIGN.

3.4.1 DESIGN FLOWS. All sanitary sewers and appurtenances shall be designed to carry the design flows from all contiguous areas that may be tributary thereto. Studies may be required to determine sewer design flow and adequate gravity and pressure sewer infrastructure sizes.

Sanitary sewers shall be designed to carry the peak discharge as specified below; also, all sewers shall be designed to transport suspended material so as to preclude the deposition of any solids in the sewer line.

New sewer systems shall be designed on the basis of an average daily per capita flow. Sanitary sewer systems shall be designed to prohibit infiltration and ex-filtration. To provide for peak loads, sanitary sewers shall be designed to carry, when full, not less than that shown in table 3.2.

TABLE 3.2
SANITARY SEWER DESIGN FLOWS

Laterals and Mains (< 15" diameter) . . . . . 400 gallons/capita/day Outfall Lines (≥ 15" diameter). . . . . 250 gallons/capita/day

All sewers shall be designed and constructed with hydraulic slopes sufficient to give mean velocities (when flowing 2/3 full) of not less than 2.0 feet per second, based on Manning's formula, using a value for "n" of not less than 0.013. The minimum slopes to be provided shall be as shown in table 3.3, unless approved otherwise by the City Engineer.

TABLE 3.3
SANITARY SEWER MINIMUM SLOPES

SEWER SIZE (Inches	MINIMUM SLOPE (ft/100 feet)	MAXIMUM NUMBER OF DWELLINGS
4	1.00	3
6	0.60	10
8	0.50	300
10	0.40	500
12	0.35	750
15	0.30	1200
18	0.25	1900
21	0.20	2600
>24	0.15	3200

NOTE: Maximum dwelling units for four and six inch pipe sized for service laterals, eight inch and above sized for sewer main.

The Engineer must furnish computations for velocities and depth of flow for grades in excess of 10% and for extremely low flow situations. No grades in excess of 15 percent will be allowed.

3.4.2 MINIMUM SIZE AND DEPTH. No public sanitary sewer shall be less than eight inches in diameter. Minimum size of house connections shall be four-inches in diameter. Minimum size of restaurant connections shall be six-inches in diameter. Only one residence, structure, or building in separate ownership shall be served by each lateral connected to the public main. (See Uniform Plumbing Code, Chapter 3)

In general, sanitary sewers shall be designed to a depth of 9 feet to the pipe invert to permit sewer laterals from basements to be connected. Exceptions may be granted in subdivisions or areas in which basement-less buildings are to be constructed. In such case a note to that

effect shall be made on all plans presented for approval. In no case shall sanitary sewers be designed for a depth of cover less than 36 inches over the top of the sewer pipe. All sewers shall be designed to prevent damage from superimposed loads as well as trench loading conditions.

3.4.3 ALIGNMENT. In general, all sanitary sewers shall be designed for uniform slope and alignment between manholes and shall be laid a distance of at least 10 feet (horizontally) from any existing or proposed water main. In the event that a sewer main cannot be laid at least 10 feet from an existing or proposed water main, then the City Engineer may authorize the implementation of the provisions of section 12.2.1 of the State of Utah Public Drinking Water Regulations. Sewer mains and manholes shall be located in improved dedicated City streets. City owned sewer mains and manholes shall not be permitted on private property or behind homes unless no other alternative exists to provide gravity flow in the sewer main. The inability to provide gravity flow from the home shall not be a justification for the sewer mains not being located in the street. Sewer mains not located in improved dedicated City streets shall have a utility maintenance access road installed per the standard drawings.
All Sewer laterals shall intersect the sewer main on the top third of the sewer main pipe as shown in the standard drawings and extend perpendicular from the sewer main pipe to the lot.

3.4.4 SERVICE CONNECTIONS. Service connections to any public sanitary sewer shall be made only to a wye installed at the time of the sewer main installation or by a machine tap and approved saddle wye or "insert-a tee" compatible with existing main line sewer material in accordance with the standard drawings and shall be a minimum of 10 feet, measured horizontally, from any culinary water line or tapping. All connections and service lines must be watertight. All sewer clean-outs shall be made according to the standard drawings. New subdivisions shall install a sewer lateral per the standard drawings on the main sewer for each proposed lot. The lateral shall be located 10 feet from the low lot line.

All sewer laterals connected to public sewer mains shall conform to table 3.4.

All restaurants, food service establishments and other buildings that use high amounts of grease or oil shall have grease, oil, and sand interceptors with sampling manhole as specified in Section 3.4.7.

TABLE 3.4
SANITARY SEWER LATERALS

TYPE OF UNIT OR RESIDENCE	MINIMUM SEWER LATERAL SIZE (Diameter)	MINIMUM SLOPE
Single Family Residences	4 inches	2%
Town-homes	4 inches/unit	2%
Commercial Establishments	6 inches	1%
Mobile Homes	4 inches	2%
Apartments/Multi-Family Condominium Complexes	See notes below	

NOTES:

1) Lateral size and slope shall be based on the number of fixture units in the apartment or multi-family condominium complexes, in accordance with the Uniform Plumbing Code.

2) Under no circumstances shall roof drains, foundation drains, storm drains or sub-drains be connected to the sanitary sewer system.

3.4.5 SEWER MANHOLES AND GREASE TRAPS WITH SAMPLING MANHOLES. Manholes shall be installed at all changes in grade, direction, size, or at all intersections; and at distances no greater than 400 feet apart for main lines and 500' apart for outfall lines. All manholes shall be accessible to maintenance vehicles, and all sewer easements shall provide at least 20 feet of unobstructed width. Drop manholes shall be provided for a sewer line entering a manhole at an elevation of 18-inches or more above the manhole invert. Floor troughs shall be furnished for all sewers entering manholes, and shall be at least as deep as the full diameter of the sewer main in the manhole.

When a smaller sewer main joins a larger sewer main in a manhole, the top of pipe elevations shall match.

All manholes shall conform to the detailed dimensions, construction details and materials as shown in the standard drawings. Manholes shall also conform to the conditions as detailed in Section 3, of these standards.

Sewer manholes for all sewer mains of 12 inches or less in diameter shall be a minimum of four feet in inside diameter. For sewer mains larger than 12 inches in diameter or over 12 feet in depth, or for three or more 8" or greater sewer lines flowing into a manhole, the manholes shall be not less than five feet in inside diameter.

3.4.6 SEWER LIFT STATIONS Normally all City sanitary sewer mains shall be gravity flow type. Sewer lift stations shall only be permitted and designed in accordance to local, state, and federal requirements, including City adopted fire code, building code, electric code, and State Administrative Code R317-3-3. Additionally, the following criteria and design standards shall be met. Where there is a conflict, the more stringent requirement shall apply.

I. General
   A. Lift stations are allowed when a gravity flow sewer main would have a depth in excess of 25 feet for 10% or more of the sewer main length or the gravity flow sewer main would be longer than 300 feet multiplied by the potential number of sewer connections served by the sewer main.
   B. Sewer lift station structures, electrical and mechanical equipment shall be protected from physical damage that would be caused by a 100-year flood. Sewage pumping stations must remain fully operational and accessible during a 25-year flood.
   C. Minimum duplex pump configuration shall be used in either a self-priming (Gormann-Rupp or approved equal) or dry horizontal flooded suction (Flygt, Vaughan Chopper, or approved equal) option.
   D. Where lift stations are not on the city's Sewer Master Plan, the lift station shall be designed to ultimately be eliminated and connected to future gravity flow sewer.
   E. New lift station proposals shall include a cost comparison analysis of the benefits of an added lift station over the installation of gravity sewer line.
   F. Minimum capacity of lift stations shall be sufficient to serve 400 D.U. or a minimum of 160 acres of residential or commercial property whichever is the greater flow rate.
   G. Lift stations with capacity greater than 1 million gallons per day require state review and approval prior to construction permit.

II. Design
   A. System Design Study Report
      1. Provide pump and wet well design for the potential area served with a discharge pipe designed for a minimum flow velocity greater than two (2) feet per second and a maximum velocity less than five (5) feet per second.
      2. The design engineer shall submit system-head calculations and curves. System-head curves for C values of 100, 120 and 140 in the Hazen William's equation for calculating head loss corresponding to minimum, median and maximum water levels shall be developed.
      3. A system-head curve for C value of 120 corresponding to median (normal operating) water level shall be used to make preliminary selection of motor and pump. The pump and motor must operate satisfactorily over the entire range of system-head curves for C values of 100 and 140 corresponding to minimum and maximum water

levels intersected by the head-discharge relationship of a given pump.

4. The system shall be designed and constructed for peak flow at full buildout. If more than 2 pumps are required for full buildout, phased construction may be permitted with development. Future pumps shall be triggered by pre-determined Equivalent Domestic Unit limits analyzed in an approved sewer study.

B. Accessibility

1. The lift station shall be readily accessible by maintenance vehicles during all weather conditions which shall include a minimum 12' wide road to all off site sewer lift stations.
2. Dirt, access roads shall have a finish grade of 6" minimum of compacted road base. Dirt access roads shall be crowned at the center line of right-of-way and 2% slope away from crown.
3. The facilities shall be located off the traffic way of streets and alleys. Lift station facilities shall have a clearance area no less than 20' from exterior of any building, wet well, valve pit, etc.
4. Access gate shall be a minimum of 16' in width, and in line with wet-well manhole/grate, to provide access to specialty cleaning/maintenance vehicles.

C. Grit: Where it is necessary to pump sewage before grit removal, the design of the wet well and pump station piping shall be such that operational problems from the accumulation of grit are avoided.

D. Odor and Corrosion Control: The pumping station design should incorporate measures for mitigating the effects of sulfide corrosion to structure and equipment; and excessive odor control when a populated area is within close proximity.

E. Structures

1. Pump and motor enclosures and facilities, including their superstructure, shall be completely separated from the wet well.
2. Provision shall be made to facilitate maintenance and removal of pumps, motors, and other mechanical and electrical equipment including, but not limited to, 3' of clearance around any interior wall and/or wall mounted equipment in excess of control panel door's opening tolerances, and 7' minimum height for all overhead conduits, piping, gas lines and any other obstructions.
3. Safe means of access and proper ventilation shall be provided to all facilities and wells containing mechanical equipment requiring inspection or maintenance.
    a. For recessed dry wells, a stairway with rest landings shall be provided at vertical intervals not to exceed 12 feet (3.7 meters). Where a landing is used, a suitable and rigidly fixed barrier shall be provided to prevent an individual from falling past the intermediate landing to a lower level.
    b. Where space requirements are insufficient; the design may provide for a man-lift or elevator in lieu of landings in a

factory-built station if the design includes an emergency access or exit and shall not be classified as "confined space".

4. The materials selected in construction and installation must be safe and able to withstand adverse operating environmental conditions caused by presence of hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in sewage.
5. Lift stations shall have walk-in pump enclosures with masonry walls, metal roof, interior/exterior lights, heat, vent fans, 15-gallon trash can, storage cabinet, wash down sink, faucet and floor drain (or submersible pump, if required), dry well water spigot (hose bib), 120 volt electrical outlets and service water per building code.
6. No wet well shall be deeper than 25' below finish grade, and shall be accessible via City maintenance and cleaning equipment.
7. Site Planand grading plan per Standard Drawing S7 showing fenced yard with 6-foot chain link fence, 16-foot gate, 3-inch drain rock ground cover, sloped at 2% from wet well to the fence, set-backs per zoning ordinance, 20-foot minimum from the fence to the enclosure and/or lift station equipment, a SCADA system and panel with internet communications (fiber or broadband), and alarm notifications. Also included in the lift station design package shall be a design for the pressure discharge pipe (green or purple PVC C-900 DR-18) with thrust blocks, restraint joints, clean-outs, blow-offs, and in-line gate valves spaced at 1000 feet maximum, pipe locate wire (12-gage solid copper with terminal boxes), locate posts, pressure line/manhole connection detail. All installation and testing shall comply with the requirements of the equipment manufacture and City Engineering Standards. Refer to Standard Drawings S5 for additional requirements and specifications for sewer lift stations.

III. Pumps

A. Multiple Units

1. A minimum of two pumps shall be provided for all sewer lift stations and shall have the same capacity. Each shall be capable of handling flows in excess of the expected maximum flow.
2. A minimum of three pumps shall be provided for lift stations where design peak-flows will be 1 million gallons per day (3,785 cubic meters per day) or greater. Where three or more units are provided, they shall be designed to fit actual flow conditions and must be of such capacity that with any one of the units out of service, the remaining units shall have capacity to handle flows in excess of the expected maximum flow.
3. All pumps shall be 480 volt, 3-phase with auxiliary power connections and gas driven stand by generators or motors. See emergency operations for additional information.

B. Protection Against Clogging

1. All lift station designs shall take precaution to provide protection against clogging.
2. Non-mechanically cleaned bar screens will NOT be acceptable.
3. Mechanically cleaned and duplicate bar screens or grinders shall be installed in lift stations handling estimated peak flows of 1 million gallons per day or greater.
4. For lift stations less than 1 million gallons per day, grinders may be considered, at the discretion of the Wastewater Collections Department Head.

C. Pump Openings: Except where grinder pumps are used, pumps shall be capable of passing spheres of at least 3 inches (7.6 centimeters) in diameter, and pump suction and discharge piping shall be at least 4 inches (10.2 centimeters) in diameter.

D. Priming: The pump shall be so placed that it will operate under a positive suction head under normal operating conditions.

E. Electrical Equipment: Electrical systems and components (e.g., motors, lights, cables, conduits, switchboxes, and control circuits) in raw sewage wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, shall comply with the National Electrical Code requirements for Class 1 Group D, Division 1 locations. In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each flexible cable shall be provided with watertight seal and separate strain relief. A fused disconnect switch located above ground shall be provided for all pumping stations. When such equipment is exposed to weather, it shall as a minimum, meet the requirements of weatherproof equipment (NEMA 3R). All electrical equipment and clearance requirements shall comply with latest National Electrical Code standards.

F. Intake: Each pump should have an individual intake. Turbulence shall be avoided near the intake in wet wells. Intake piping shall be as straight and short as possible.

G. Dry Well Dewatering: A separate sump pump equipped with dual check valves shall be provided in dry wells to remove leakage or drainage. Discharge shall be located as high as possible. A connection to the pump suction is also recommended as an auxiliary feature. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump.

H. Controls
1. Controls and alarms shall be compatible with City proprietary SCADA system. SCADA control panels shall be wall mounted per specification requirements and accessible, including 3’ minimum clearance.
2. MODBUS controls shall be provided in pump panels.
3. Control systems for liquid level monitoring shall be of the air bubbler

type or level transducer type, and shall also include a single, high level, fail-safe float. All electrical equipment shall comply with all National Electrical Code requirements.

4. The level control system shall be located away from the turbulence of incoming flow and pump suction.
5. The design engineer must consider automatic alternation of the sequencing of pumps in use.
6. Incoming power from the main feed shall have a power meter sensor.

I. Valves

1. Check valves shall be placed on the suction line of each self priming pump.
2. Isolation valves shall be placed on the suction line of each flooded suction pump.
3. Discharge Line
   a. Isolation and check valves shall be placed on the discharge line of each pump. The check valve shall be located between the isolation valve and the pump.
   b. Check valves shall not be placed in the vertical run of discharge lines after the primary isolation valve.
   c. Within the building or fenced perimeter, and after the isolation valve shall be a force main shut off valve.
   d. All valves shall be suitable for the material being handled, and capable of withstanding normal operating pressure and water hammer.
   e. Where limited pump backspin will not damage the pump and low discharge head conditions exist, a short individual force main for each pump, may be approved by the Wastewater Collections Department Head in lieu of a discharge manifold.

J. Wet Wells

1. Size. The wet well size and level control settings shall be appropriate to avoid heat buildup in the pump motor due to frequent starting (short cycling), and septic conditions due to excessive detention time, and shall be sized for a minimum 10-year peak flows, preferably 20 year peak flow requirements.
2. Floor Slope. The wet well floor shall have a minimum slope of one to one to the hopper bottom. The horizontal area of the hopper bottom shall be not greater than necessary for proper installation and function of the pump inlet.
3. Discharge lines shall NOT pass through wet wells.
4. Wet wells shall be of non-corrosive construction (Armorock or equal), or spray lined with chemical-resistant polyurethane coatings (Sprayroq or equal), and finished before placed into service.
5. Wet well design shall provide sufficient storage capacity to allow for detection of and response to lift station failure.
6. Access to wet well will be a dual hatch door with safety grates.

Material will be constructed of non corrosive material. All mounting hardware including, but not limited to, bolts, anchors, brackets and hangers will be stainless steel.

K. Ventilation

1. All pump stations must be ventilated to maintain a safe operating environment. Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well if screens or mechanical equipment requiring maintenance or inspection are located in the wet well. There shall be no interconnection between the wet well and dry well ventilation systems. In pits over 15 feet (4.6 meters) deep, multiple inlets and outlets are recommended. Dampers should not be used on exhaust or fresh air ducts. Fine screens or other obstructions in air ducts should be avoided to prevent clogging. Switches for operation of ventilation equipment should be marked and located for convenient operation from outside of the enclosed environment. All intermittently operated ventilating equipment shall be interconnected with the respective pit lighting system. Automatic controls are recommended for intermittently ventilated pump stations. Fan parts should be of non-corrosive material. All parts adjacent to moving ones should be of non-sparking materials. Consideration should be given to installation of automatic heating and dehumidification equipment.
2. Wet Wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Ventilating equipment should force air into wet well rather than exhaust it from wet well.
3. Dry Wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 6 complete air changes per hour; if intermittent, at least 30 complete air changes per hour.

L. Flow Measurement. Continuous measuring and recording of sewage flow shall be provided at all pumping stations with a design pumping capacity greater than one million gallons per day (3,785 cubic meters per day).

M. Water Supply. There shall be no physical connection between any potable water supply and a sewage pumping station which under any condition might cause contamination of the potable water supply. The potable water supply to a pumping station shall be protected against cross connection or backflow.

N. Self-priming pumps shall be capable of rapid priming and repriming at the lead pump on elevation. Such self-priming and repriming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed 25 feet (7.6 meters) in total length. Priming lift at the lead pump on elevation shall include a safety factor of at least 4 feet (1.2 meters) from the maximum

allowable priming lift for the specific equipment at design operating conditions. The combined total of dynamic suction lift at the pump off elevation and required net positive suction head at design operating conditions shall not exceed 22 feet (6.7 meters).

IV. Alarm Systems

A. Alarm systems shall be provided for lift stations. The alarm shall be activated in cases of power failure, high water level in dry or wet well, pump failure, use of the lag pump, air compressor failure, or any other pump malfunction.

B. Lift station alarm systems shall be compatible with current SCADA program in use by Cedar City Wastewater Collections.

V. Emergency Operation

A. Pumping stations and collection systems shall be designed to prevent bypassing of raw sewage and backup into the sewer system. For use during possible periods of extensive power outages, mandatory power reductions, or uncontrolled storm events, a controlled emergency power generator shall be provided.

B. The generator shall have auto-start and fueled by natural gas, supplied by a utility line coming into the site. The generator shall be rated to provide sufficient output power to run all pumps, ventilation, lighting, and auxiliary loads continuously. If a stand-alone external generator is used, it must be in an appropriate, weather rated enclosure.

C. Engine Protection. The engine must be protected from damaging operating conditions. Protective equipment shall shut down the engine and activating an alarm. Protective equipment shall monitor for conditions of low oil pressure and overheating, Oil pressure monitoring is not required for engines with splash lubrication.

D. Engine Ventilation. The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.

E. Routine Start-up. All emergency equipment shall be provided with instructions indicating the need for regular starting and running of such units at full loads.

F. Protection of Equipment. Emergency equipment shall be protected from damage at the restoration of regular electrical power.

VI. Instructions and Equipment

A. Sewage pumping stations and their operators must be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, special tools, and necessary spare parts.

VII. Force Main

A. Velocity. A velocity of not less than 2 feet per second (0.61 meter per second) shall be maintained at the average design flow, to avoid septic sewage and resulting odors.

B. Air Relief Valve. An automatic air relief valve may be requested at high points in the force main to prevent air locking.

C. Termination. Force mains should enter the gravity sewer system at a point not more than 2 feet (30 centimeters) above the flow line of the receiving manhole.

D. Design Pressure. The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

E. Special Construction. Force main construction near streams or used for aerial crossings shall meet all National and State code requirements.

F. Design Friction Losses

1. Friction losses through force mains shall be based on the Hazen-Williams formula or other hydroaulic analysis that may be justified to determine friction losses. When the Hazen-Williams formula is used, the design shall be based on the value of C equal to 120; for unlined iron or stell pipe, the value of C equal to 100 shall be used.
2. When initially installed, force mains will have a significantly higher C factor. A changing C factor over the life of the system must be considered when calculating friction loss, capacity, and power requirements.

G. Separation from Water Main. The applicant or the design engineer must review the requirements stated in State Code R309-112.2 - Distribution System rules, Drinking Water and Sanitation Rules, to assure compliance.

H. Identification. A clearly labeled tracer location tape shall be placed two feet above the top of force mains along its entire length.

3.4.7 GREASE, OIL, AND SAND INTERCEPTOR WITH SAMPLING MANHOLE. Grease, Oil, and Sand Interceptors, shall mean a device for separating and retaining waterborne fats, oil, and greases before the wastewater exits the interceptor into the city's wastewater collection system or POTW. The interceptor also collects settable solids generated by or incidental to commercial, industrial and/or food preparation activities. The calculations for future grease interceptor capacity will be based on available tenant space, and/or flow through retention time. The Interceptor shall at a minimum be equipped with a two-cell construction and be constructed of impervious materials capable of withstanding abrupt and extreme changes in temperature. All grease, oil and sand interceptors shall conform to detailed dimensions, construction details and materials as shown in the standard drawings, and the Cedar City Pretreatment Ordinance 30-a.

A sampling manhole shall also be installed with each grease, oil and sand interceptor. The sampling manhole shall conform to the engineering standards and standard drawings for sewer manholes as contained here-in.

3.5 CULINARY WATER DESIGN. All culinary water mains and appurtenances within Cedar City shall be designed to provide for adequate future service for all contiguous areas that may, within a reasonable period in the future, be tributary thereto.

3.5.1 DESIGN FLOW PRESSURE. Water mains shall be designed to provide a minimum residual pressure of 20 psi under maximum day demand conditions including designed fire flow (as called out in Section 3.5.7 of these Standards). A minimum of 35 psi residual pressure must be maintained under normal peak hour conditions without fire flow.

3.5.2 PEAK INSTANTANEOUS FLOW: Peak instantaneous flow as determined in Section 5.1 of the State of Utah Public Drinking Water Regulations, shall be as follows:

Residential (indoor use -- not including fire flow):

$$Q_i = 10.8\ N^{0.64}$$

where:

Q_i = Total indoor flow (in gpm) delivered to all connections.

N = Total number of equivalent residential connections.

Peak instantaneous flow shall be assumed for outdoor use as follows:

$$Q_o = 1.85 Q_i$$

where:

Q_o = Total outdoor flow (in gpm) delivered to all connections.

$Q_i = Q_i$ as defined above.

Peak instantaneous total flow Q_t shall be: $Q_t = Q_i + Q_o$

Peak instantaneous fire flows shall be added to peak instantaneous domestic flows for distribution system design flow total.

Commercial or industrial areas may require special investigation to determine fire flow requirements. Existing and future static pressure and flow information used in the design must be obtained from or approved by the City Water Department Superintendent.

3.5.3 MINIMUM SIZE AND DEPTH. The minimum depth of cover (to the top of the pipe) for water mains shall be three feet below the final grade of the street. Where final grades have not been established, mains shall be installed to a depth great enough to insure three

feet of cover below future grade based on the best information available. The water mains shall be sized to deliver the peak instantaneous flow rate as determined in Section 3.5.2. The fire flow requirements and pressures shall be as outlined in Section 3.5.7. The minimum size water mains serving any fire hydrant shall be eight-inches in diameter unless hydraulic analysis indicates the required flow and pressures can be maintained by a six-inch diameter line.

3.5.4 VALVES AND HYDRANTS. The water distribution system shall be looped as outlined in Section 3.5.7.II and valves shall generally be spaced such that a break in any one length of main will put no more than 1000 feet of main nor more than three fire hydrants out of service (whichever is less) while maintaining adequate minimum service in the remainder of the water system during repairs. Valves in transmission mains shall be spaced at maximum intervals of one mile. All distribution mains connecting to transmission mains shall be valved at the connection. All fire hydrant runs shall also be valved.

Valves generally shall be located at street intersections where the water mains connect.

Valves 8-inches and smaller shall be Gate Valves and all valves larger than 8-inches shall be Butterfly Valves.

3.5.5 PRESSURE REDUCING VALVES: The Cedar City Water Department recommends that in high-water-pressure zones in the City, secondary pressure reducing devices be installed by the owner on all water connections to buildings. The locations of the high-water-pressure zones within the City can be located and identified upon request from the Cedar City Water Department.

3.5.6 FIRE HYDRANT SPACING AND LOCATION: Generally, fire hydrants shall be spaced and located as follows:

I. At each intersection, on the end of a cul-de-sac and generally on the same sides of the street.

II. In residential areas, fire hydrant spacing shall be no greater than 500 feet and no house shall be more than 250 feet from a hydrant via a street access to the property being served.

III. In multiple family areas, P.U.D. zones, industrial, business or commercial areas, fire hydrant spacing shall require special investigation to determine the hydrant spacing per the International Fire Code.

IV. Generally, hydrants shall be located in line with extensions of the property line when located mid-block.

V. Hydrants shall be placed at least one foot from the back of the sidewalk, with a three-foot elliptical radius of clearance to adjacent obstacles and with the lowest

water outlet not less than 18 inches nor more than 30 inches from the final ground elevation. (See standard drawings)

VI. All fire hydrants to be installed on dedicated easements or public rights-of-way will be owned and maintained by the Cedar City Water Department.

3.5.7 FIRE FLOW REQUIREMENTS: Under maximum day demand conditions, fire flow shall be according to the latest International Fire Code. The total system design shall be such that fire flows and normal peak instantaneous flow demand (as called out in Section 3.5.2 of these standards) can be met while still maintaining a minimum pressure of 20 psi at all points in the distribution system.

High-density residential, commercial or industrial areas shall require special investigation to determine fire flow requirements and hydrant spacing per IFC. Existing and future static pressure and flow information used in the design shall be obtained from or approved by the Cedar City Water Department.

3.5.8 MISCELLANEOUS WATER SYSTEM DESIGN CRITERIA.

I. All public water mains shall be installed in an easement at least 10 feet in unobstructed width or in public rights-of-way with adequate access for maintenance vehicles.

II. Permanent dead-end mains shall be avoided wherever possible and if installed, shall not exceed 500 feet. Connections on any dead-end water main shall not exceed 250 equivalent residential units. Hydrants shall be located at the end of dead-end mains for flushing purposes as well as for fire protection. Blow-off valves rather than fire hydrants shall be used for initial line blow-off or blow-out after line repairs have been made. Blow-off valves shall be installed per the standard drawings.

III. Each building shall be served by a separate line and meter except in PUD's as approved by the City Engineer; however, in some situations a common tap and service line from the main to a manifold with two meter setters and boxes may be installed to serve two adjacent properties. All lots shall have a minimum of 1" service line from the main to the meter box.

IV. All service line taps shall be machine tapped at the time of the water main installation. Service lines shall be installed prior to testing and acceptance of the water main.

V. Water mains shall be laid at least 10 feet horizontally from any existing or proposed sewer main. The distance shall be measured edge to edge. If necessary and where approved by the City Engineer, Section 12.2.1 of the State of Utah Public Drinking Water Regulations can be implemented.

VI. When a water main crosses over a sewer main, the water main shall be laid at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer. When the water main cannot be as high as 18 inches above the sewer, the sewer shall be constructed of material with pressure conduit standards for a distance of 20 feet on either side of the crossing.

VII. All tees, bends, plugs and hydrants shall be provided with reaction blocking, tie rods, and joints designed to prevent movement, i.e. " mega lug" or approved equal. Wood blocking of future main extensions are not acceptable. Concrete thrust blocks shall be formed and poured in place and must bear against undisturbed soil, per the thrust block details in the standard drawings.

VIII. Air release-vacuum assemblies and blow-off valves shall be provided on all mains larger than 12 inches where required to prevent damage due to air accumulations.

IX. No access to water meters or fire loop leak detectors shall be placed in driveways, parking stalls or sidewalks.

X. All materials that may come in contact with drinking water, including pipes, gaskets, lubricants and O-Rings, Shall be ANSI-certified as meeting the requirements of ANSI/NSF Standard 61, Drinking Water System Components – Health Effects. To permit field-verification of this certification, all components shall be appropriately stamped with the NSF logo.

XI. Above Water Crossings: the water pipe shall be adequately supported anchored, protected from damage and freezing, and accessible for repair or replacement.

Underwater Crossings: The water pipe shall be installed per standard details W-12 and W-13.

XII. No water connections will be allowed off City's transmission lines, unless there are no other alternatives and the connection is approved in writing by the City Water Superintendent.

3.6 OTHER UTILITIES SYSTEMS DESIGN. All other utility systems within Cedar City shall be designed to meet the following specifications:

3.6.1 RESPONSIBILITY. Other necessary utility installations, (Gas, Electricity, Telecommunications, and T.V.), will be coordinated by the developer.

3.6.2 STREET LIGHTS. All developments shall include street lights and necessary wiring installed at the owner's expense in accordance with these standards and the local power

company's specifications.

3.6.3 BURIAL OF LINES. All subdivision and planned unit development utility lines shall be underground. Lines shall be buried at a minimum depth of 32". No lines shall be buried in any water or sewer trench.

3.6.4 LAYOUT. Utility lines shall be placed within designated utility easements as shown in the standard drawings.

3.6.5 FRONT LOT LINE SYSTEMS. Where front lot lines are used, other utility system construction shall not begin until the completion of water, sewer, curb and gutter, but must be complete before installation of street asphalt.

3.6.6 QUALITY CONTROL. All utility trench construction shall conform to the design and testing requirements set forth in Section 3.2 (pipeline construction) of these standards.

SECTION 4

CONSTRUCTION STANDARDS

4.1 EARTHWORK. This section defines the requirements for excavation and backfill for structures; construction requirements for embankments and fills; subgrade preparation for pavements and other surface improvements.

4.1.1 DEFINITIONS:

I. EMBANKMENT shall refer to any raised area of compacted earth to support a roadway, structure, parking lot, etc. The material used for embankment shall be specified, and tests shall be performed to determine the fill material's adequacy for the specific project.

II. FILL shall refer to any material used to fill a depression, and can be any material which can be compacted enough to prevent settlement such as earth, broken-up concrete, old building blocks, crushed stone or material from a riverbank, etc. (Embankment is a type of fill.)

III. BACKFILL shall refer to any earth that has been excavated from a trench or other excavation and then replaced and compacted as specified after the structure has been installed.

IV. SUBGRADE shall refer to the native, prepared original soil or engineered fill under any roadway, fill, embankment, structure, etc.

V. MAXIMUM DRY DENSITY as determined by ASTM D 1557.

4.1.2 MATERIALS. Earthwork materials in City improvements shall conform to the following:

I. EXCAVATION. All structures shall be founded on prepared original soil or engineered fill. All unauthorized excavation below the specified structure subgrade shall be replaced with concrete or untreated base course thoroughly compacted to a minimum of 95% of maximum dry density. Subgrade soil for all concrete structures, regardless of type or location, shall be firm and thoroughly compacted to a minimum of 95% of maximum dry density for granular soils or 90% of maximum dry density for silty/clay soils as classified by AASHTO M-145 soil classification system.

II. COARSE GRAVEL**.** Coarse gravel or crushed stone may be used for subsoil reinforcement when approved by the City Engineer. Such material shall be applied in six-inch layers, each layer being embedded in the subsoil by thorough tamping. All excess soil shall be removed to compensate for the displacement of the gravel or crushed stone, and the finished elevation of any subsoil reinforced in this

manner shall not be above the specified sub-grade.

III. BACKFILLS. Backfill shall be placed to the lines shown on the approved drawings, or as directed by the City Engineer. After completion of construction below the elevation of the final grades, and prior to backfilling, the excavation shall be cleaned and all forms, trash and debris shall be removed. Backfill material shall consist of approved excavated material or clean borrow sand, gravel or other suitable material, and shall be placed in layers compatible with the equipment and not exceeding twelve inches in compacted thickness. Each layer shall be compacted to a minimum density of 95% of maximum dry density for granular soils, or 90% of maximum dry density for silty/clay soils as classified by AASHTO M-145 soil classification system.

4.1.3 CONSTRUCTION METHODS. The methods employed in performing the work shall be the responsibility of the developer. The developer shall make such changes in the methods employed as are necessary to install an acceptable finished product. These methods shall include but are not limited to the following:

I. CONSTRUCTION OF EMBANKMENTS. Unsuitable materials that occur in the foundations for embankments shall be removed by clearing, stripping and/or grubbing. Soils used as roadway embankment material shall be approved by a licensed geotechnical engineer or the City Engineer. All materials in embankments shall be placed, moistened, and compacted as provided in the following paragraphs.

When the embankment exceeds the amount of excavation, sufficient additional material shall be obtained from borrow pits provided by the Contractor. All material proposed to be imported shall be subject to the review and approval of the City Engineer prior to starting of hauling operations. The materials used for embankment construction shall be free from sod, grass, trash, rocks larger than six inches in diameter and all other material unsuitable for construction of embankments. The material shall be a granular material as classified by AASHTO M-145 soil classification system.

Grading of completed embankments and backfills shall bring the surfaces to a smooth, uniform condition with final grades being within 0.1 foot of the design grade. Cut and fill slopes shall be 2 horizontal/1 vertical maximum. Construction of slopes steeper than 2 horizontal/1 vertical, or fills in excess of 5 feet, shall be approved by the geotechnical engineer.

II. COMPACTION OF EARTH MATERIALS. The fill material shall be deposited in horizontal layers having a thickness of not more than twelve inches and then compacted to the specified density as herein specified. Moisture content during compaction operations shall be within two % optimum for granular soils and at two to five % above optimum for fine-grained soils. The moisture content shall be uniform throughout the layers.

If the moisture content is greater than specified for compaction, the compaction operations shall be delayed until such time as the material has dried to the optimum moisture content. When the material has been conditioned as herein specified, the backfill or embankment shall be compacted as follows:

Under roadways, curb and gutter, sidewalks, and driveways, and extending one foot beyond the proposed construction, the embankment material shall be compacted to a density equal to not less than 95%. Other fills and embankments not listed above shall be compacted to 90% maximum dry density.

Exposed natural soils within building areas, beneath walkways, slabs and pavement shall be scarified to a depth of six inches, moisture conditioned, and compacted to the specified density. Where hard, cemented material or rock is exposed, scarification is not necessary.

Foundations for structures shall not be placed partially on undisturbed soil or compacted fill and partially on cemented deposits or rock.

Foundation soils shall not be allowed to become saturated during or after construction.

III. SUBGRADE PREPARATION. The original soils under roadways, curb and gutter, sidewalks, and driveways shall be scarified to a depth of six inches prior to compaction operations. All road subgrade shall be compacted to the equivalent of 95% of maximum dry density for granular soils or 90% of maximum dry density for silty/clay soils as classified by AASHTO M-145 Soil Classification System. No organic material, soft clay, spongy material or other deleterious material will be permitted in the subgrade. Subgrades shall be shaped and graded to within a tolerance of 0.10 foot of design grade and drainage shall be maintained at all times. Subgrades shall be stabilized and compacted as directed by the City Engineer. Any springs or underground water encountered in the construction of the streets shall be properly disposed of in accordance with the instructions of the City Engineer.

When required to demonstrate the stability and compaction of the subgrade, the contractor shall proof-roll the subgrade prior to laying any base gravel. The

subgrade shall be proof-rolled with at least one pass coverage with a pneumatic tired roller of at least ten-ton capacity. All proof-rolling shall be accomplished in the presence of the engineer. Ground contact pressure for all tires shall be 85 to 90 psi.

When the proof rolling shows an area to be unstable, it shall be brought to satisfactory stability by additional compaction, reworking, or removal of unsuitable material and replacement with acceptable material.

IV. CONSTRUCTION OF NON-STRUCTURAL FILLS. Fills shall be placed to the lines shown on the drawings and shall be any areas not specifically designated for support of structures or utilities (such as landscape areas, open space areas, etc.). Fill material shall have no specific compaction requirements but shall consist of material that can be compacted to prevent settlement such as rocks, old building blocks, crushed stone, broken-up concrete, boulders, etc. Fill material shall not include deleterious materials such as muck, ash, sod, grass, trash, tree stumps, lumber, dead animals, etc.

4.1.4 QUALITY CONTROL. All earthwork shall be performed in accordance with these standards and shall be tested and accepted as follows:

I. TESTING. Minimum testing of earthwork shall be as follows:

Soil Classification -	One per material source. The sieve analysis shall be according to ASTM C136, C117.
Soil Proctor -	One determination for each significant change in soil type as necessary to provide required compaction testing. Tests shall be ASTM D 1557 method A or D (modified proctor).
Earth fill moisture/ density determination -	One test per 500 cubic yards of fill placed in an embankment. Tests shall be ASTM D1556 or D2922 and D3017.
Subgrade moisture/ density determination -	One test per 1000 square yards of surface area. Moisture density determinations shall be made in accordance with Section 3 of the City Standards. Tests shall be ASTM D1556 or D2922 and D3017.

II. ACCEPTANCE. Any earthwork determined not to be in compliance with these standards shall be removed and replaced or reworked until compliance is obtained. Any costs for the rework or testing the rework shall be paid for by the developer.

4.1.5 SPECIAL EARTH WORK REQUIREMENTS. In areas of Cedar City where a geotechnical investigation is required before development, the recommendations of the geotechnical report shall be followed. The requirements outlined previously in this section are only a minimum.

4.2 PIPELINE CONSTRUCTION: This section covers the requirements for material trenching, placement, backfilling, cleaning and testing of underground pipelines and incorporates the requirements of the AWWA Standards and Manufacturers Recommended Installation Procedures, whichever is more stringent. Backfill shall include filling of all trenches to the original ground surface or final grading elevation as shown on the drawings, or otherwise directed by the appropriate city departments.

4.2.1 MATERIALS. This section specifies acceptable pipe and accessories for public sanitary sewers, underground culverts, storm drains, and water pipe construction within Cedar City. The materials used for pipe and fittings shall be new and shall conform to the requirements for class, brand, size and material as specified.

I. SEWER PIPE: Only those pipes listed below may be used in the construction of sanitary sewer lines in Cedar City.

A. P.V.C. PLASTIC SEWER PIPE: This Specification covers rigid polyvinyl chloride pipe and fittings, hereinafter called PVC fittings. PVC pipe and fittings from 4 inches to 15 inches in diameter shall meet or exceed all of the requirements of ASTM Specification D 3034 with a minimum wall thickness to diameter ratio of SDR-35. PVC pipe and fittings from 18 inches to 27 inches in diameter shall meet or exceed the requirements of ASTM F 679.

Each pipe used shall have a manufacturer's stamp on it indicating that it complies with the requirements of the appropriate specification. Any pipe not so stamped shall be rejected.

All pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects. All PVC sewer pipe shall be made from clean, virgin, Type 1, Grade 1, Polyvinyl Chloride conforming to ASTM Resin Specification D 1784.

All pipe joints shall be bell and spigot type with rubber ring gasket to permit expansion and contraction. Pipe and fittings shall be assembled with a non-toxic lubricant. Pipes of 4-inch and 6-inch diameter may be the solvent weld type. Pipe shall have the following minimum SDR-35 dimensions:

NOMINAL PIPE SIZE (INCHES)	OUTSIDE DIAMETER (INCHES)	MINIMUM WALL THICKNESS (INCHES)
4	4.215	0.125
6	6.275	0.180
8	8.400	0.240
10	10.500	0.300
12	12.500	0.360

Spigot ends shall have a 15° tapered end with a memory mark around the diameter of the pipe to indicate proper insertion depth.

B. A.B.S. COMPOSITE AND SOLID WALL SEWER PIPE: This specification covers Acrylonitrile-Butadiene-Sturine (ABS) gravity sewer pipe. All ABS composite sewer pipe shall conform to the latest revision of ASTM Specification D 2680. The ABS material used shall be a virgin rigid plastic conforming to ASTM Specification D 1788 for rigid ABS plastics. The other component shall be Portland Cement, Perlite concrete, or other inert filler material exhibiting the same degree of performance.

All solid wall ABS pipe shall conform to ASTM Specifications D 2751. Solid wall pipe used for laterals shall have a minimum wall thickness to diameter ratio of SDR-35. Fittings not described by these standards shall be shop fabricated or molded from materials listed in Paragraphs 4 and 5 of ASTM D 2680 and shall be of equivalent quality to those described.

All field joints shall be chemically welded. Primer, then cement, shall be applied liberally to the outside of the spigot end and the inside of the coupling immediately prior to stabbing the pipe together. The pipe spigot end shall be supplied with home marks to assure proper jointing.

C. RIBBED PVC PIPE: Ribbed PVC sewer pipe (Ultra Rib by Uponor ETI or equal) may be used on all sanitary sewers and storm drains greater than 12-inch diameter when approved by the City Engineer. All ribbed pipe shall be seamless open profile and meet the requirements of ASTM

F794 and Uni-Bell Uni-B-0. Pipe shall have a smooth interior with a solid cross-sectional rib exterior. Exterior ribs shall be perpendicular to the axis of the pipe to allow placement of the sealing gasket without additional cutting or machining. The pipe stiffness shall be a minimum of 46 psi when tested at 5% deflection in accordance with D2412. Pipe shall be green or white in color. The filler material used in the pipe (calcium carbonate) shall not exceed 10% by volume.

D. SEWER PIPE FITTING All sewer and storm drain pipe fittings including service lateral connections, tees, repair couplings, etc., shall be of the same material and thickness class as the main pipe. Flexible couplings (i.e. Fernco Couplings) or cast in place concrete collars will not be allowed.

II. STORM DRAIN PIPES: All pipes listed under section 4.2.1.I "Sewer Pipes" of these standards as well as the following pipes may be used in the construction of storm drain lines and culverts in Cedar City.

A. NON-REINFORCED CONCRETE PIPE: Non-reinforced concrete sewer pipe may be used for storm drains up to and including 24-inch size unless otherwise specifically designated in these Standards or on the approved Drawings. Pipe shall be extra strength pipe manufactured to comply with the requirements as set forth in ASTM Designation C 14, Class 3 unless otherwise approved by the City Engineer. Joints shall be of the bell and spigot with rubber gasket design, and with joints and gaskets conforming to the requirements of ASTM Designation C 443. Pipe joints shall be so designed as to provide for self-centering, and when assembled, to compress the gasket to form a watertight seal. The gasket shall be confined in a groove on the spigot so that pipe movement or hydrostatic pressure will not displace the gasket.

B. REINFORCED CONCRETE PIPE: Reinforced Concrete Pipe shall be used for all storm drains using concrete pipe greater than 24 inches in diameter. Reinforced concrete pipe shall comply with the requirements of ASTM C 76 (Class II) unless otherwise approved by the City Engineer. Joints shall be of the bell and spigot design with rubber gasket type joints for storm drains, with an alternate option of tongue and groove mortar joints for elliptical pipe when approved by the City Engineer.

C. CORRUGATED POLYETHYLENE PIPE**:** Corrugated Polyethylene pipe shall be high-density polyethylene corrugated exterior/smooth interior pipe. 12 to 24-inch diameters shall conform to AASHTO M 294 Type S, or ASTM F 2306. Materials shall conform to ASTM D 3350. All pipe joints, gaskets, and fittings shall be water tight according to ASTM F2306, F477 and D 3212 and conform to AASHTO M294, and shall be approved by the City Engineer. Corrugated Polyethylene pipe shall not be used for any pipes larger than 24- inches. If cover over Corrugated Polyethylene pipe is less than 1 foot use flowable fill for backfill.

D. CORRUGATED POLYPROPYLENE PIPE**:** Corrugated Polypropylene pipe shall be ADS HP (High Performance) Storm Pipe corrugated exterior/smooth interior pipe, or approved equal. Corrugated Polypropylene pipe may be used for storm drain pipes greater than 24 inches in diameter as

an alternative to Reinforced Concrete Pipe. The maximum allowable pipe diameter for Corrugated Polypropylene pipe is 60 inches. Corrugated Polypropylene (PP) pipe shall be smooth interior and annular exterior corrugated polypropylene (PP) pipe meeting the requirements of ASTM F2881 or AASHTO M330, Type S, for respective diameters. The pipe supplied shall be watertight as defined in the joint performance requirements of the manufacturer's specifications. Virgin material and fitting production shall be an impact modified copolymer meeting the material requirements of ASTM F2881 and AASHTO M330, for respective diameters. Watertight joints shall be bell-and-spigot meeting the watertight requirements of ASTM F2881. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly. Corrugated Polypropylene pipe shall be installed according to manufacturer's recommendations and Cedar City Engineering Standards.

III. SEWER MANHOLES: This section covers the requirements for the materials used in sanitary sewer and storm water manholes. Manholes shall be watertight and be furnished complete with cast iron rings and covers as follows:

A. CONCRETE BASES: Manhole bases shall be pre-cast. Cast-in-place manhole bases will only be allowed if approved by the City Sewer Collections Division. The concrete shall conform to the requirements of Section 4.4 of these Standards.

Where sewer lines pass through or enter manholes, the invert channels shall be smooth and semi-circular in cross section. Changes of direction of flow within the manholes shall be made with a smooth curve with the longest radius possible. The depth of the channel in the manhole base shall be the full diameter of the sewer pipe being used at that manhole. The floor of the manhole outside the flow channels shall be smooth and slope toward the channel at not less than one-half inch per foot or more than one-inch per foot.

B. WALL AND CONE SECTIONS: All manholes shall be constructed of either 48-inch or 60-inch inside diameter pre-cast, sectional, reinforced concrete. Both cylindrical and taper sections shall conform to all requirements of ASTM Designation C 478 for pre-cast reinforced concrete manhole sections and shall have ladders according to the standard drawings.

Throat sections of manholes shall be adjustable by use of appropriate diameter pipe sections up to 18 inches in height.

The taper section shall be a maximum of 3 feet in height, shall be of eccentric

conical design, and shall taper uniformly from 48 or 60 inches to 30 inches inside diameter. Cones shall be set on the manhole sections so that the top opening of the cone is centered over the centerline of the sewer.

Sixty-inch inside diameter sewer manholes shall be required for all sewers greater than 18 inches in diameter or deeper than 12 feet, or where 3 or more 8-inch or greater lines converge in the manhole.

The base section of the manhole shall be furnished in section lengths of 1, 2, 3, and 4 feet as required.

All joint surfaces of pre-cast sections and the face of the manhole base shall be thoroughly cleaned prior to setting the sections. Joints shall be sealed with a one-inch flexible joint sealant, which shall conform to the requirements of ASTM C 923.

C. WATER-TIGHTNESS. Water-tight concrete shall be required in all concrete manholes. Any cracks or imperfections developing at any point in the work shall be satisfactorily repaired. Materials and methods used shall be subject to approval of the City Engineer.

D. IRON CASTINGS. All iron castings shall conform to the requirements of ASTM A 48 (Class 30) for gray iron castings. Frames and covers shall have a minimum combined weight of 402 pounds.

The cover and ring seat shall be machined so that the entire area of the seat will be in contact with the cover, in any position of the cover on the seat. Frames and covers shall be so constructed and machined that the parts are interchangeable. The tops of the cover and frames shall be flush, and the clearance between the frame and cover shall be 1/8 of an inch all around. The top surface of each cover shall be cast with a ribbless cross hatch design including the word "Sewer". Letters and design shall be recessed 1/4". Each cover shall be provided with not less than twelve ventilating holes of 3/4-inch diameter each.

All manhole frames shall be carefully set to the finished grade or as directed by the City Engineer. Manhole frames shall be set in place on the manhole throat and shall be sealed with an approved flexible joint sealant that shall conform to the requirements of ASTM C 923. Frames or covers loosened from the manhole throat shall be reset and any frames, covers or throat sections damaged or broken, shall be replaced prior to acceptance by the City.

E. MANHOLE STEPS. Manhole steps shall be constructed in accordance with the drawing "Manhole for Sanitary & Storm Sewer" as shown in the

standard drawings of these standards and shall be similar in construction to the manhole step as manufactured by M.A. Industries, Inc., of Peachtree City, Georgia.

The steps shall be constructed of number four (one-half-inch diameter) grade 60 reinforcing steel bars bent and embedded in Copolymer Polypropylene Plastic.

The Copolymer Polypropylene Plastic, used to embed the reinforcing bars in, shall conform to the requirements of ASTM 214, Type II grade 43758, and the reinforcing bar shall conform to the requirements of ASTM A 615.

Manhole steps shall be installed at intervals not to exceed 16 inches between steps, be firmly cast into the concrete wall and taper sections of all manholes to a minimum depth of 3-3/8 inches, as shown in the drawings, and form a solidly anchored step which will not pull out or break under repeated use.

IV. WATER PIPE AND FITTINGS. The materials used for pipe and fittings shall be all new and shall conform to the requirements for class, brand, size and material as specified.

A copy of the manufacturer's installation recommendation for each kind of pipe shall be provided to each foreman prior to construction. These recommendations shall be followed during construction. All pipe materials are as follows:

A. GENERAL PIPE REQUIREMENTS: Pipe materials shall conform to the following:

SIZE	TYPE
3/4" – 1"	Copper Type K or SDR-9 poly pipe CTS (copper tubing size) allowed under certain conditions
1 1/2" – 2"	Rigid Copper Type K (sweat fittings) or SDR-9 poly pipe CTS (copper tubing size) allowed under certain conditions
Over 2" – 8"	Ductile Iron Class 50 or PVC C900 DR-18 (Pressure Class 235 psi) allowed under certain conditions
Over 8"	Ductile Iron Class 50

B. CONNECTION WATER METERS: Only authorized employees of the City Water Department shall be allowed to connect or disconnect water meters. All boxes set in concrete shall be flanged to prevent settlement.

NOTE: Where these Standards refer to AWWA Standards, a copy of these standards is available for review at the Cedar City Water Department.

C. DUCTILE IRON PIPE: All ductile iron pipe shall be Class 50 conforming to the latest edition of AWWA Specifications C-151 (ANSI A21.51). Pipe and accessories shall be gauged at sufficiently frequent intervals to insure that dimensions are in accordance with Table 51.3 and 51.4 of AWWA Specifications C-151-76 for the gauge in accordance with the Standard Dimensions. The inside diameters of the sockets and the outside diameters of the spigot ends shall be tested with circular gauges.

Unless otherwise specified, all Ductile Iron Pipe furnished under these Standards shall be designed in accordance with AWWA Specification C-150-76 "American National Standard for the Thickness Design of Ductile Iron Pipe." The maximum allowable variation with the standard pipe thickness shall not be more than those shown in table 4.1 and note:

TABLE 4.1
DUCTILE IRON PIPE TOLERANCE

PIPE DIAMETER (INCHES)	MINUS TOLERANCE (INCHES)
3-8	0.05
10-12	0.06
14-42	0.07
48	0.08

Note: An additional tolerance of 0.02 inches shall be permitted over areas not exceeding 8 inches in length.

1. PHYSICAL AND MECHANICAL PROPERTIES: The Ductile Cast Iron Pipe shall conform to all requirements of the ANSI Specification A21.51. The physical properties shall not be less than 60-42-10.

Each pipe shall be subjected to a hydrostatic test of not less than 500 psi. The test may be made either before or after the standard outside coating and bituminous inside coating have been applied, but shall be made before the application of a cement lining or of a special lining.

The pipe shall be under the full test pressure for at least ten seconds. Any pipe that leaks shall be rejected.

2. MARKING: Each pipe shall be legibly marked "Ductile". The weight, a manufacturer's mark, and the year in which the pipe was produced shall be cast or marked on the pipe.

3. INSPECTION: The manufacturer shall establish the necessary quality control and inspection practice to assure compliance with these standards. The manufacturer shall, if required by the City Engineer, furnish a certified statement that the inspection and all the specified tests have been made and the results thereof comply with the requirements of these standards. When the City Engineer desires to inspect the pipe at the manufacturer's plant, the City Engineer will so specify and state the extent of the inspection. The City's inspector shall have free access to those parts of the manufacturer's plant that are necessary to assure compliance with these standards. The manufacturer shall provide the inspector with assistance to handle pipe as may be necessary.

4. REJECTION OF PIPE: At least one tensile and one impact sample shall be taken during each casting period of approximately three hours. Samples shall be selected to properly represent extremes of pipe diameters and thicknesses. If the results of any physical acceptance test fails to meet the requirements of these standards, all pipe cast in the same sampling period shall be rejected. The manufacturer may determine the extent of rejections by making similar additional tests of pipe until the rejected lot is bracketed (in order of manufacturer) by an acceptable test at each end of the period of question. When pipe of one size is rejected from a sampling period, the acceptability of pipe of different sizes from the same period may be established by making the routine acceptance test for these sizes.

5. JOINTS: Ductile Iron Pipe shall be either Mechanical Joints, Rubber Gasket Slip-on Joints, Flanged Joints, or a combination of the above as specified on the plans.

a. MECHANICAL JOINTS. Mechanical joints and the rubber gaskets and lubricant for Ductile Iron Pipe shall comply with the requirements and be dimensioned in accordance with the latest edition of AWWA specifications C-104, C-110 and C-111.

Bolts and rubber gaskets shall be furnished with mechanical

joint pipe in sufficient quantity for the amount of pipe ordered.

b. RUBBER GASKET SLIP-ON JOINT. Rubber gasket slip-on joints, and the rubber gaskets and lubricant for Ductile Iron Pipe shall comply with the general requirements of AWWA C-151 and C-111.

Rubber gasket slip-on joints shall be designed for assembly by pre-positioning of a single continuous molded rubber ring gasket in an annular recess in the pipe socket to form a positive seal. The plain end of the pipe shall be suitably beveled to facilitate assembly.

The design and shape of the gasket, and the annular recess therefore, shall be such that the gasket is locked in place against displacement as the joint is assembled. The gasket shall provide adequate compressive force between the plain pipe end and the socket after assembly to effect a positive seal under all combinations of joint and gasket tolerances.

Details of the joint and rubber ring gasket design and assembly shall be in accordance with the pipe manufacturer's standard practice. The pipe supplier shall furnish the City Engineer detailed drawings in quadruplicate showing the design of the joint prior to casting said pipe. The design of the joint shall be subject to the approval of the City Engineer.

The recess in the pipe socket for the rubber ring shall be free of all coating materials and sand pits.

Rubber gaskets and lubricant shall be furnished with rubber gasket joint pipe in sufficient quantity for the amount of pipe ordered.

c. FLANGED JOINTS. Cast iron pipe flanges, and bolts and nuts therefore, shall be dimensioned in accordance with ANSI B-16.2 for Class 200. Threads for screw-on flange pipe shall comply with ANSI B-21. Flange bolts, nuts and gaskets shall be furnished with flange joint pipe in sufficient quantity to make each joint for the pipe ordered. Flanged fittings and spools shall conform to AWWA C-104, C-110 and C-115.

6. LINING AND COATING: The waterway surfaces of all Ductile Iron water pipe and fittings shall be completely covered with a

uniform thickness of cement-mortar which shall be further covered with a bituminous seal coat, all in accordance with AWWA C-104. The bituminous seal coat may be omitted if the cement lining is given a 7-day water cure during which the lining is kept consistently damp.

Ductile Iron Pipe or Fittings lined in the field will not be accepted as conforming to AWWA C-104.

The outside surface of all Ductile Iron Pipe for general use under all normal conditions shall have a bituminous coating of coal tar primer approximately 1 mil thick, unless otherwise specified. The finished coating shall be continuous and smooth. It shall be neither brittle when cold, not sticky when exposed to the sun, and shall strongly adhere to the pipe.

7. POLYETHYLENE WRAPPING: A polyethylene wrap will be required on all ductile iron pipe laid in corrosive soils. The polyethylene wrap tubing shall be cut to provide for a minimum of one foot of lap over both the adjoining pipes. The ends of the tubing shall be wrapped using three circumferential turns of plastic adhesive tape. The loose wrap on the barrel shall be pulled snugly around the barrel of the pipe and the excess folded over at the top. This fold shall be held in place by means of six-inch strips of plastic tape placed at intervals of three feet along the pipe barrel.

Bends, reducers, and offsets shall be wrapped in the same manner as the pipe. Valves shall be wrapped by bringing the tube wrap on the adjacent pipe over the bells of the valve and sealing with adhesive tape. The valve bodies shall then be wrapped with flat sheets passed under the valve bottom and brought up around the body to the stem and fastened with the tape.

D. POLYVINYL CHLORIDE (PVC) C900 DR-18 PIPE:

1. DR Rating: All Polyvinyl Chloride (PVC) C900 Pipe shall be DR-18 (Pressure Class 235 psi) conforming to the latest applicable AWWA specifications.
2. Sand Bedding and Trench Conditions: A minimum of six (6) inches of sand bedding is required underneath the PVC waterline and poly service laterals. It is required to backfill around the PVC waterline and poly service laterals, and to a height of at least one foot over the pipe with sand for all PVC and poly waterlines. As an alternative, native soil material can be used for the bedding and pipe zone if the native soil is fine-grained material and approved by the geotechnical engineer.

3. Pipe Backfilled at End of Working Day: All PVC waterlines will need to be backfilled with at least 12 inches of cover over the pipe at the end of each working day. PVC pipe can be affected by temperature and cause problems with installation.
4. Maximum Working Pressure of PVC C900 set at 150 psi: The maximum working pressure for PVC waterlines is set at 150 psi. Ductile iron pipe is required in all locations where the working pressure is above 150 psi. Also, PVC waterlines are not allowed in areas where the working pressure is reduced below 150 psi by means of pressure reducing valve (PRV). Ductile iron pipe is required in areas located downstream of a PRV.
5. Joint Restraints: Mega-lug joint restraints and thrust blocks are required at all fittings and elbows on PVC waterlines. A special mega-lug thrust restraint is required for PVC fittings in order to prevent damage to the PVC pipe.
6. Maximum Pipe Diameter of PVC C900 set at 8-inch: The maximum allowable waterline diameter for PVC C900 is 8-inch diameter. All waterlines over 8-inch diameter must be Ductile Iron Class 50.
7. Pipe Deflection and Pipe Bending is Not Allowed: During the installation of PVC pipe there must be no attempt to bend the pipe or deflect the pipe at a joint. All changes in direction must be made by using fittings only. PVC pipe must be installed using a laser, similar to sewer pipe installation, to ensure that the pipe installation meets these requirements.
8. Tracer Wire and Caution Tape: All PVC waterlines and poly service laterals are required to have tracer wire installed along the pipeline. The tracer wire shall be 12 gauge type UF insulated copper locate wire. The tracer wire must be duct-taped or zip-tied to the waterline at maximum 10-foot intervals along the pipe. After installation, the tracer wire must be tested for continuity between all access points. Any discontinuities in the tracer wire must be repaired to the satisfaction of the City. At all splices, the tracer wire must be connected with gel-filled wire connectors. Wire nuts will not be allowed. At locations where the pipe material transitions from ductile iron to PVC, the tracer wire must be cad-welded (fused) to the ductile iron pipe. Magnetic caution tape is required 12 inches above the PVC waterline along the full length of the trench.
9. Storage of PVC Pipe to Prevent Sun Exposure: PVC pipe must be stored in a building to prevent exposure to sunlight and keep the pipe at ambient temperature. PVC pipe showing evidence of sun burning shall not be installed.
10. Service Laterals (3/4" – 2" sizes): When using PVC C900 pipe, the service laterals can be installed as SDR-9 poly pipe CTS (copper tubing size), ASTM D2737, rated for 250 psi working pressure.
11. PVC Pipe Tapping: Tapping new service laterals into pressurized

PVC pipe can be difficult. All workers who tap PVC pipe must be trained on proper tapping techniques. Workers need to be trained in doing taps and take all safety precautions to prevent damage to the pipe and to prevent injury.

12. Inspection of Pipe Prior to Installation: All PVC C900 pipe shall be carefully inspected by the City inspector pior to installation. Any pipe with scratches, gouges, dents, cracks, sun burning, or other imperfections will be rejected.
13. Construction Inspection: All PVC waterlines and poly service laterals must be inspected by City inspectors in the trench prior to burying the pipe. The inspection will ensure that proper bedding has been installed underneath the pipe, there is proper clearance to the trench bank, that proper pipe zone material is being installed, the PVC pipe is inserted properly at each bell, and that there are no deflections or bends in the PVC pipe. PVC waterlines and poly service laterals must not be buried until a visual inspection has been conducted and approved for backfill by City inspectors. Regular compaction tests are also required by a certified geotechnical testing firm.
14. Warranty: A standard 1-year warranty applies to PVC waterlines and poly service laterals.
15. Contractor Education and Certification: The Uni-Bell PVC Pipe Association offers virtual training seminars regarding PVC pipe installation. All workers on crews installing PVC pipe are required to take the PVC pipe installation course. The standard installation course only needs to be taken once. However, if contractors have new workers on their crew that will be installing PVC C900, then those workers will need to take the course. All contractors will need to be certified in the installation of PVC pipe in order to work on Cedar City projects.
16. As-built Drawings and Survey Coordinates: Accurate as-built drawings of PVC pipe are critical to ensure that the pipes can be located in the future. Mylars, PDF, and CAD as-built files are required. As-built survey points will be required at the following locations along PVC waterlines:
    - At all changes in pipe direction including elbows, tees, and crosses.
    - At every 200 feet of pipe length.
    - At all valves, air vacs, vaults, etc.
    - At all corp stops and meter barrels.
    - Other locations as directed by the City to ensure accurate as-builts drawings.

E. COPPER PIPE: Where service lines are two-inch or less in diameter, type K copper pipe must be used when the main line is Ductile Iron Class 50. Pipe that has outside dimensions greater than two-inch in diameter shall not

be copper. All copper pipe shall conform to the following specifications:

1. MATERIAL: Pipe shall be used which conforms to the requirements of ASTM B88. The pipe shall be of a Type K only and shall be dimensioned so as to allow the connection to AWWA standard water service taps and fittings. The pipe shall have surfaces smooth and free from bumps and irregularities.

2. PIPE JOINTS: All pipe joints on Copper pipe shall be soldered joints using ASTM B813, water flushable, lead-free alloy solder; and ASTM B-828 procedure, or all brass compressive couplings with grip rings Ford C44 Pack Joint Coupling or approved equal unless otherwise specified.

3. SERVICE CONNECTIONS: The installation of service connections shall use only connections, equipment and practices recommended by the manufacturer. The service connection shall conform to the detail drawing shown in the standard drawings.

F. FITTINGS: Fittings shall be K-Copper or Cement Lined Ductile Iron, "Tyler, Star" or an approved equal and have a pressure rating as may be required by the static pressure along the pipeline. All fittings shall be dimensioned according to ANSI A-21.10 or A-21-53 (AWWA C 110 or C 153) "American Standard for Cast Iron Fittings, 3 inches through 48 inches, for Water and other Liquids", and shall be equipped with restraining joints (mega-lug or equal).

G. TAPPING/REPAIR CLAMP MATERIAL SPECIFICATION:

1. SMALL TAPS/REPAIR CLAMPS: For small tappings and repair clamps (3/4" through 3") on cast iron, steel or ductile iron pipe, the following materials shall be required:

a. SADDLE CASTINGS: Small saddle tappings shall be similar to "Romac Stainless Steel Saddles" Model 202NS constructed of high tensile ductile (modular) iron, in accordance with ASTM specification 536-71, and shall be covered by a black nylon, plastic or epoxy fused coat, approximately 10-12 mils thick, with an approximate dielectric strength of 1000 volts per mill. The pressure rating of the tapping saddle shall equal the maximum static pressure along the pipeline.

b. STAINLESS STEEL STRAP: Stainless steel straps shall consist of two two-inch wide straps to spread out the

clamping force on the pipe and shall come complete with sufficient bolts, nuts and washers (with five-eighths-inch N.C. Teflon coated roll threads) to properly clamp the strap to the pipe. M.I.G. welds shall be passivated for resistance to corrosion. The pressure rating of the tapping saddle shall equal the maximum static pressure along the pipeline.

c. GASKETS: Gaskets shall be made from virgin SBR compounded for water services.

2. LARGE TAPS/REPAIR CLAMPS: For large taps and repair clamps (larger than 3") on Cast Iron, Steel or ductile iron pipe, the following materials shall be required:

a. CUT IN TEE: The preferred method of making large taps or pipe repairs is to cut in a cement lined Ductile Iron tee with couplings and valves as specified in these Standards.

b. SLEEVES: Taps or pipe repairs can be made using sleeves that are either cast iron with an asphalt tar varnish coating or epoxy coated steel with stainless steel bolts Romac fabricated steel tapping sleeve Model FTS 420 or approved equal. No stainless steel sleeves will be allowed. All sleeves shall have a working pressure rating equal to the maximum static water pressure along the pipeline.

Tapping sleeve shall only be used when the tap is smaller than the pipe being tapped.

c. TAPPING VALVES: Tapping valves shall conform to Section 4.2.1.IV.G.1.

H. VALVES AND BOXES: All valves, eight inches and smaller shall be of a resilient-seat-gate-valve type, and all valves over eight inches shall be butterfly valves unless otherwise specified by the City Water Department.

1. GATE VALVES: Valves shall conform to the latest revision of AWWA Resilient Seated gate valve Standard C-509 and be UL listed, FM approved. All internal parts shall be accessible without removing the body from the line. The wedge shall be of cast iron completely encapsulated with resilient material. The resilient sealing material shall be permanently bonded to the cast iron wedge with a rubber tearing bond to meet ASTM D 429. NRS stems shall be cast bronze or 18-8 Type 304 or 316 stainless steel with internal collars in compliance with AWWA. OS&Y stems shall be bronze. The NRS

stuffing box shall have two "O"-Ring seals above the thrust collar. These rings shall be field replaceable without removing the valve from service.

There shall be low friction thrust bearings above and below the stem collar. The stem nut shall be independent of the wedge and of solid bronze. The waterway in the seat area shall be smooth, unobstructed and free of cavities. Stuffing box shall be attached to the bonnet and the bonnet to the body with bolts and nuts. All exposed bolts and nuts on the valve, not including flange bolts and nuts, shall be stainless steel. The body and bonnet shall be coated interior and exterior with corrosion resistant coating. Each valve shall be hydrostatically tested at 400 PSI to the requirements of both AWWA and UL/FM. Valve flange bolts and nuts shall be Zinc Coated Carbon Steel ASTM A307A Grade A.

Valves shall be installed vertically in a horizontal run of pipe, and shall be provided with a two-inch square operating nut for manually operating the valve with a "T" handle wrench. The direction of rotation to open shall be to the left (counter-clockwise).

2. BUTTERFLY VALVES: All butterfly valves shall be of the tight-closing, rubber-seat type with rubber seats that are securely fastened to the valve body. No metal-to-metal seating surfaces shall be permitted. Valves shall be bubble-tight at rated pressures with flow in either direction, and shall be satisfactory for applications involving valve operation after a long period of inactivity. Valve discs shall rotate 90 degrees from the full open position to the tight shut position. Butterfly valves shall meet the full requirements of AWWA Standard C504 for Class 150B for areas with a static water pressures less than 150 psi without the use of pressure reducing valves, and Class 250B for all other areas. The manufacturer shall have manufactured tight-closing, rubber-seat butterfly valves for a period of at least five years. All valves shall be similar to those as manufactured by the Henry Pratt Company or approved equal.

Valve bodies shall be constructed of cast iron ASTM A-126 Class B (for flanged end valves) or ASTM A-48 Class 40 for wafer type valves. Flange drilling shall be in accordance with ANSI B16.1 Standard for cast iron flanges. Two trunnions for shaft bearings shall be integral with each valve body. Body thickness shall be in strict accordance with AWWA Standard C504. All exposed bolts and nuts on the valve, not including flange bolts and nuts, shall be stainless steel. Valve flange bolts and nuts shall be Zinc Coated Carbon Steel ASTM A307A Grade A.

Valve discs shall be constructed of alloy cast iron ASTM A436 Type I (Ni-Resist).

Shafts of all valves shall be turned, ground and polished. Valve shafts shall be constructed of 18-8 Type 304 or Type 316 stainless steel. Shaft diameters shall meet minimum requirements established by AWWA Standard 75 lbs. pull under test procedure ASTM D-429, Method B.

Valves shall be fitted with sleeve-type bearings. Bearings shall be corrosion resistant and self-lubricating. Bearing load shall not exceed one-fifth of the compressive strength of the bearing of shaft material. Packing shall be self-adjusting Chevron type. Valve operators shall conform to AWWA C504.

Manual operators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Operators shall be equipped with mechanical stop-limiting devices to prevent over-travel of the disc in the open and closed positions. Valves shall close with a (clockwise) rotation. Operators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 lbs. on the hand-wheel or chain-wheel. Operator components shall withstand an input of 450 Ft. Lbs. at extreme operator position without damage.

3. VALVE BOXES: All valves shall be provided with a Cast Iron valve box of the extension screw type, and the correct adjustable height to bring the top of the valve box flush with the ground surface. The valve box shall not be less than five inches in diameter and shall have a minimum thickness of .375 inch. The box provided also shall be provided with a suitable base and cover. The word "WATER" shall be cast on the cover.

I. WATER SERVICE LATERALS: The material used for water service connections shall comply with the following:

1. COPPER SERVICE PIPE: Copper service pipe shall be seamless and suitable for use as copper underground service connections and shall conform to Section 4.2.1.IV of these Standards.

2. SDR-9 POLY PIPE CTS (COPPER TUBING SIZE): All SDR-9 poly pipe CTS (copper tubing size) shall meet ASTM D2737, rated for 250 psi working pressure.

3. CORPORATION STOPS: Corporation stops shall be similar to those manufactured by the Mueller Company or Ford, with a rated working pressure of 200 PSI minimum:

	WATER SERVICE CONNECTION SIZE	
	3/4”	1"
MUELLER CO.	H-15008	H-15008
FORD	B-1000-G	B-1000-G

Corporation stops shall have grip joint compression couplings for the copper service pipe and threaded on the inlet end with an AWWA corporation stop thread. Gate valves with valve box shall be required on all water service connections greater than 1 inch.

4. METER SETTER YOKES: Meter setters or meter yokes shall be 18" high, Ford 70 series copper setter or equal, and shall have an AWWA approval, built-in back-flow device and inlet angle ball valve and grip joint compression couplings for copper tubing on both inlet and outlet. All internal parts shall be accessible without removing the setter from the line. Meters shall only be installed by City Water Department personnel.

5. METER BOX AND LID**:** The meter boxes shall be white, high density polyethylene ADS N-12 or equal, 18" X 36" (standard size). Refer to Cedar City Detail W5 for water meter lid requirements.

6. BUILDING SERVICE CONNECTIONS: At all points designated by the City Engineer, the owner shall install services for building connections, and shall extend such services to the property line, unless otherwise indicated by the City Water Department. Individual water services shall be 1 inch from the water main to the meter setter for normal domestic service, but may be one-and-one-half or two-inches in diameter as directed by the City Water Department. Services shall have a minimum of three feet of cover and be laid as shown in the standard drawings.

J. FIRE HYDRANTS: Fire Hydrants shall be Mueller, Modern Centurion, Model A-423; Kennedy, Model K81A; American AVK; or approved equal with 400 PSI test pressure, 200 PSI working pressure, 5 1/4" dia. 3 nozzle, foot valve and 6" mechanical joint connection. Fire hydrants shall conform to the latest edition of AWWA C-502, "Dry Barrel Fire Hydrants." All exposed bolts and nuts, not including flange bolts and nuts, on the fire hydrant that are underground shall be stainless steel. Valve flange bolts and

nuts shall be Zinc Coated Carbon Steel ASTM A307A Grade A. It shall be the responsibility of the Owner to furnish hydrants with a finish paint above the ground line identical to the existing hydrant paint (red). All exposed bolts and nuts that are below ground level on the fire hydrant shall be stainless steel.

V. FLOWABLE BACKFILL: Flowable backfill material shall conform to the following:

A. Portland Cement - Type I or II Subsection 718.01.

B. Fly Ash - ASTM C-618, Class F, except loss on ignition shall not exceed three percent maximum, and shall come from a source approved by the City Engineer.

C. The coarse and fine aggregate for flowable fill shall be natural and consisting of mineral aggregate particles meeting the following:

Sieve Size	Percent Passing
3/4	100
200	0-10

D. Mix Design (See Section 4.4 Concrete Work for Mix Design Submittal)- meet the following:

Minimum compressive strength (28 days)	50 PSI
Maximum compressive strength (28 days)	150 PSI
Minimum fly ash per cubic yard	300 lbs.
Maximum cement per cubic yard	50 lbs.
Maximum slump	10 in.

VI. PIPELINE CASINGS: Pipeline casings shall conform to the following:

A. Casing Material – The casing material shall be smooth, uncoated carbon steel casing pipe with a minimum yield strength of 35,000 PSI and a minimum wall thickness of 0.375 inches.

B. Casing Size – The casing size shall be sufficient to maintain a 2 inch minimum clearance between the greatest outside diameter of the carrier pipe (including pipe bells) and the minimum interior diameter of the casing pipe. Minimum clearance shall be maintained around the entire pipe circumference.

C. Casing Chocks or Skids- Casing chocks or skids shall be Power Seal 4810 casing chocks or equal approved by the City Engineer. Casing chocks or skids shall support the carrier pipe at a maximum of every 7 feet and install according to the manufactures directions.

D. Casing Seals- The annulus between the carrier pipe and casing on both v ends of the pipe casing shall be sealed with a neoprene boot and stainless steel straps provided by Power Seal or equal approved by the City Engineer.

E. Carrier Pipe Joints- The joints of the carrier pipe inside the case shall be joints that resist slipping by using either locking gaskets, glued or other non-slip type joints approved by the City Engineer.

VII. SPARE COMMUNICATION CONDUITS- A minimum of one 2-inch gray, Schedule 40 PVC conduit with a nylon twin pull string with 500 pounds of pull strength shall be installed at least in one of the City sewer, storm drain or water line trenches required for any development.

4.2.2 CONSTRUCTION METHODS This section covers the requirements for trenching, placement, and back filling of all underground pipelines (sewer, water, storm drains, etc.). The methods employed in performing the work shall be the responsibility of the developer. The developer shall make such changes in the methods employed as are necessary to install an acceptable finished product. These methods shall include but are not limited to the following:

I. CONTROL OF GROUND WATER: All trenches shall be kept free from water during excavation, fine grading, pipe laying, jointing, and embedment operations. Where the trench bottom is mucky or otherwise unstable because of the presence of ground water, and in cases where the static ground water elevation is above the bottom of any trench or bell hole excavation, such ground water shall be lowered to the extent necessary to keep the trench free from water and the trench bottom stable when the work within the trench is in progress. Surface water shall be prevented from entering the trenches.

II. EXCAVATION FOR PIPELINES: Trench excavation shall include all operations necessary for excavation of all materials of whatever nature falling within the designated lines of the trenches. Trenches shall be excavated to the lines shown on the drawings or otherwise established by the City Engineer, and to a depth so as to provide a minimum burial of three feet over the pipe unless otherwise specified. The bottom two feet of the trench walls shall be vertical. All finish grade excavation necessary for preparation of the trench bottom shall be made manually. No over-excavating shall be allowed without re-compaction of backfill in accordance with these Standards.

Excavation for trenches in ledge rock, cobble rock, or stones shall extend to a depth of at least four inches below the invert of the pipe. Bedding material as outlined in table 4.2 shall be placed and compacted to 95% of maximum dry density with pneumatic or vibratory tampers in six-inch lifts to provide a smooth, well compacted and stable foundation for the pipe or appurtenant works.

Trench bottoms shall be hand-shaped as specified and the maximum width of the trench, measured at the top of the pipe, shall be as narrow as possible, but not wider than 12 inches on each side of the pipe.

Where unstable earth, mud or muck is encountered in the excavation at the grade of the pipe, the unsuitable material shall be removed to a minimum of 12-inches below grade and the subsequent hole shall be backfilled with crushed rock or gravel (as called out in table 4.2 under "foundation material") to provide a stable subgrade. The gravel material shall be deposited over the entire trench width in a maximum of six-inch thick layers. Each layer shall be compacted by tamping, rolling, vibrating, spading, slicing, rodding or by a combination of one or more of these methods. In addition, the material shall be graded to produce a uniform and continuous support for the entire length of the installed pipe. Where soil migration may be an issue, a filter fabric barrier may be required.

TABLE 4.2
BACKFILL MATERIALS

SIEVE SIZE	PERCENT PASSING FOR:			
	FOUNDATION MATERIAL*	BEDDING MATERIAL	PIPE ZONE MATERIAL	FINAL BACKFILL MATERIAL
2 inch	100	---	---	Native material which contains no sod, vegetation, rocks larger than 8" in diameter, asphalt or concrete chunks, etc.
3/4 inch	0 – 50	100	100	
No. 4	0 – 10	---	40 - 70	
No. 50	0 – 5	---	20 - 50	
No. 200	0 – 3	0 - 15	5 - 30	

*To be used only when the trench bottom is unstable.

(The standard drawings show the typical trench backfill details.)

III. SHEETING, BRACING AND SHORING OF EXCAVATIONS: All excavations shall be sheeted, braced, and shored as required to protect the workers and existing utilities and improvements from sliding, sloughing or settling of the trench walls while the work is in progress. All such sheeting, bracing and shoring shall comply with the requirements of the Utah State Industrial Commission. All damage resulting from lack of adequate sheeting, bracing and shoring shall be the responsibility of the Contractor, and the Contractor shall effect all necessary repairs or reconstruction resulting from such damage.

IV. BLASTING: Blasting will not be allowed except by written permit from the Cedar City Fire Chief. If the permit is granted, the Contractor shall comply with all laws, ordinances, and applicable safety code requirements and regulations relative to the handling, storage, and use of explosives and protection of life and property.

The contractor shall comply with the provisions outlined in the U.S. Bureau of Mines Bulletin No. 656 "Blasting Vibrations and their Effects on Structures", and other applicable ordinances as specified by the Fire Chief.

The contractor shall be fully responsible for all damage attributable to such blasting operations. Excessive blasting or overshooting will not be permitted and any material outside the authorized cross-section, which may be shattered or loosened by blasting, shall be removed and properly replaced.

V. PIPE LAYING AND BEDDING: Pipe will be carefully inspected in the field by City Inspectors before and after laying. If any cause for rejection is discovered in a pipe after it has been laid, it shall be removed and replaced by the Contractor.

When connections are to be made to any existing pipe, conduit, or other appurtenances, the actual elevation or position of which cannot be determined without excavation, the Contractor shall excavate for, and expose the existing improvement before laying any pipe or conduit. The City Inspector shall be given the opportunity to inspect the existing pipe or conduit before the connection is made. Any adjustments in line or grade that may be necessary to accomplish the intent of the plans will be made.

Pipe shall be laid up grade with the socket or collar ends of the pipe up grade unless otherwise authorized by the City Water Department and/or City Engineer.

Pipe shall be laid true to line and grade, with uniform bearing under the full length of the barrel of the pipe. Suitable excavation shall be made to receive the bell or collar, which shall not bear upon the subgrade or bearing. Any pipe, which is not true to alignment or shows any settlement after laying, shall be removed and re-laid to the proper grade and alignment. Wherever possible, sanitary sewers shall be installed on the down-hill side of the street.

A. REQUIREMENTS FOR LINE AND GRADE: All sewer and drainage pipe shall be installed using a pipe grade and alignment laser system. The line and grade shall be within the following limits:

1. Variance from established line and grade shall be not greater than one thirty-second (1/32) of an inch per inch of pipe diameter.

2. The total variance from line and grade shall not exceed one-half

(1/2) inch, provided that such variation does not result in a level or reverse sloping invert.

3. The variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, shall not exceed one sixty-fourth (1/64) of an inch per inch of pipe diameter.

4. The total non-concentricity variance shall not exceed one-half (1/2) inch maximum.

B. INSTALLATION OF PIPE. Bell holes shall be excavated so that only the barrel of the pipe receives bearing from the trench bottom. Large rocks (over 6 inches in least dimension) near the surface shall be removed and the hole refilled with approved backfill in accordance with table 4.2.

Sewer and drain pipe shall be laid up grade. All pipe installation shall proceed with joints closely and accurately fitted. Gaskets shall be fitted properly in place and care shall be taken in joining the units to avoid twisting the gaskets. Joints shall be clean and dry and a joint lubricant, as recommended by the pipe supplier, shall be applied uniformly to the mating joint surfaces to facilitate easy and positive joint closures. If adjustments to the position of a pipe length is required after being laid, the pipe shall be removed and rejoined as for a new pipe. When laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material. In addition to the above requirements, all pipe installation shall comply with the specified requirements of the pipe manufacturer.

C. SETTING OF BENDS, TEES, CROSSES AND REDUCERS: Bends, tees, crosses, and reducers shall be lowered into the trench, inspected, cleaned and joined to the pipe.

Reaction or thrust blocking shall be applied at bends and tees, and at points of reducing or in fittings where changes in pipe diameter occur. The design of concrete thrust blocking shall be as shown in the Standard drawings or as directed by the City Water Department. The material for reaction or thrust blocking shall be Class C in accordance with Table 4.10 and Section 4.4 of these standards. Blocking shall be placed between solid ground and the fitting to be anchored. The area of bearing on the fitting and on the ground shall in each instance be that required in the drawings or by the City Engineer. Unless otherwise directed by the City Engineer, the blocking shall be placed so that the pipe and fitting joints will be accessible for repair in accordance with the Standard Drawings. Restraining joints (mega-lug or

equal) shall also be used to prevent movement wherever thrust blocks are required.

D. PLUGGING OF DEAD-ENDS: Standard plugs shall be inserted into the bells of all dead-end fittings. Spigot ends of fittings and plain ends of pipe shall be capped. A concrete reaction or thrust block shall be provided at all plugged outlet fittings in the sizes indicated on the standard drawings or as directed by the City Engineer. They also shall be tied to the pipe with restraining joints.

E. SERVICE LINES:

1. All new water and sewer service lines shall be installed according to the details shown on the Standard Drawings.

2. When a new water or sewer service line is installed all abandoned water and sewer lines shall be cut and capped within 1 foot of the main as directed by the water or sewer collections supervisor.

F. PIPE TO BE KEPT CLEAN: All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean by means approved by the City Engineer during and after laying.

G. JOINTING PIPE SECTIONS: The sealing surface of the pipe, the bell to be joined, and the elastomeric gaskets shall be cleaned immediately prior to assembly, and assembly shall be made as recommended by the manufacturer. When pipe laying is not in progress, the open ends of installed pipe shall be closed to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, enough backfill shall be placed on the pipe to prevent floating. Any pipe that has floated shall be removed from the trench and the bedding restored. No pipe shall be laid when the trench conditions or the weather are unsuitable for proper installations as determined by the City Engineer.

H. CUTTING PIPE: The pipe shall be cut in a neat manner without damage to the pipe so as to produce a smooth end at right angles to the axis of the pipe.

I. END PREPARATION: Pipe ends shall be cut square, deburred and beveled in accordance with the pipe manufacturer's recommendations.

J. PUSH-ON JOINTS: The push-on joint shall be a single elastomeric gasketed joint that shall be assembled by positioning the elastomeric gasket in the annular groove of the bell and inserting the spigot end of the pipe into

the bell. The spigot end of the pipe shall compress the gasket radially to form a positive seal. The gasket and annular groove shall be designed, sized and shaped so that the gasket will resist displacement. Care shall be taken so that only the correct elastomeric gasket, compatible with the annular groove of the bell, is used. Insertion of the elastomeric gasket in the annular groove of the bell must be in accordance with the manufacturer's recommendations.

Joint Gap tolerances for concrete pipe shall be as follows:

Inner Diameter of Pipe	Maximum Joint Gap Tolerance	Maximum Joint Gap Tolerance(with Grouting)
12” to 36”	5/8”	¾”
42” to 48”	7/8”	1-1/8”
54” to 90”	1.0”	1-1/4”
96”	1-5/8”	1-3/4”
Sizes above 96” up to 144”	As recommended by Manufacutrer	As recommended by Manufactuer

K. MECHANICAL JOINTS: The mechanical joint shall be a bolted joint of the stuffing box type, and installation recommendations from the manufacturer shall be followed. Each joint shall consist of:

1. A bell provided with an exterior gland having bolt holes or slots and a socket with an annular recess for the sealing gasket and the spigot end of the pipe.

2. A sealing gasket.

3. A follower gland with bolt holes matching those in the fitting.

4. Tee bolts and hexagonal nuts of cor-ten metal.

L. METER BOXES: All meter boxes shall be located behind the sidewalk, in the center of the lot. Any meter box covered or damaged during the construction operations shall be replaced or uncovered and raised to finish grade by the Contractor. The meter box shall be surrounded by a concrete apron as shown in the standard drawings.

M. PIPE BEDDING. Pipe shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded in accordance with the bedding details in the standard drawings.

Pipe bedding materials shall be deposited and compacted in layers not to exceed six inches in compacted thickness. Deposition and compaction of bedding materials shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be accomplished with hand or mechanical compactors. All bedding materials shall be placed in the trench with hand tools or other approved methods in such a manner that the bedding materials will be scattered alongside the pipe and not dropped into the trench in compact masses. Bedding materials shall conform to the requirements of table 4.2 of these standards and shall be free from roots, sod, or other vegetation.

In the event trench materials are not satisfactory for pipe bedding, imported bedding will be required. Imported bedding shall consist of placing compacted granular material on each side of and to the level of twelve inches above the top of the pipe. Imported bedding material shall be graded in accordance with table 4.2, under "bedding material".

VI. BACKFILLING AND COMPACTION**:** Backfill shall be carefully placed around and over pipes and shall not be permitted to fall directly on a pipe from such a height, or in such a manner as to cause damage. Backfill material shall be as required by table 4.2 or as approved by the City Engineer and shall not contain any wood, grass, roots, broken concrete, frozen soil, asphalt chunks, trash or debris of any kind that may cause unequal settlement or improper consolidation.

The backfill in all utility trenches under proposed or existing roadways, curb and gutter, sidewalks and driveways shall be compacted to the equivalent of 95% of maximum dry density for granular soils or 90% of maximum dry density for silty/clay soils as classified by AASHTO M-145 Soil Classification System. In shoulders and other street right-of-way areas, the in-place density shall be a minimum of 90% of the maximum dry density.

A. INITIAL BACKFILL PROCEDURE. Backfill of selected material, which shall conform to the requirements of table 4.2, shall be placed carefully in eight-inch non-compacted horizontal layers and tamped to a depth of 8 to 12 inches over the top of the pipe. During compaction of the initial backfill, special care shall be taken so as to not move the pipe, either vertically or horizontally and that the pie haunches are properly hand compacted to the required density. All backfill operations shall be performed in such a manner so as to avoid any damage to the pipe, valves, laterals, etc. In the event such damage or displacement occurs, such damaged or displaced pipe shall be removed and replaced with undamaged pipe on proper grade and alignment.

B. FINAL BACKFILL PROCEDURE. The backfill above a point 8 to 12 inches above the top of the pipe shall be backfilled in horizontal layers 12

inches thick or less with materials containing no brush, perishable or objectionable material, or rocks, stones or boulders larger than 8-inches in the greatest dimension. The material shall be mechanically compacted with appropriate vibrating compaction equipment.

C. MECHANICAL COMPACTION OF BACKFILL. The backfill shall be thoroughly compacted by consolidation or mechanical compaction.

Structural and trench backfill shall be deposited in horizontal layers and compacted by the following method in such manner that the compacted material will be homogeneous and free from lenses, pockets, streaks, and other imperfections.

The materials shall be deposited in horizontal layers (across the length or width of the excavation of not more than six inches compacted thickness. The excavation and placing operations shall be such that the materials when compacted will be blended sufficiently to secure the best practicable degree of compaction, impermeability and stability. Care should be taken that the compaction process does not push the pipe off line or grade.

Prior to and during compaction operations, all backfill material shall have the optimum practicable moisture content and shall be uniform throughout each layer.

Moisturizing of the materials shall be performed at the site of excavation. If the moisture content is not optimum for compaction, the compaction operations shall be delayed until such time that the material has been brought the optimum moisture content. When the material has been properly conditioned, it shall be compacted by using appropriate mechanical compaction equipment as indicated below. The compaction equipment shall not come in contact with the pipe.

1. Vibrating Rollers shall consist of a self-propelled roller with a vibrating steel drum of at least one-ton capacity. The roller shall have an effective rolling width of at least 24 inches and shall deliver a compaction force of at least 700 pounds per square inch when vibrating.

2. Pneumatic rollers shall consist of a self-propelled roller with pneumatic tires arranged in a manner so as to provide a satisfactory compacting unit. The roller shall have an effective rolling width of at least 30 inches and shall give a compaction force of at least 500 pounds per inch of width of tread when fully loaded. The tires shall be uniformly inflated.

3. Vibrating plates shall consist of a pneumatic vibrating plate attached to the boom of a backhoe and capable of compacting an area of at least three square feet. The plate and backhoe combination shall together be capable of exerting a compactive force of at least 1,000 pounds per square inch.

4. Hand Compactors shall be used when hand-compacted methods are specified or required because the location of the area to be compacted does not permit the use of self-propelled mechanical compactors. Vibrating plates, "pogo-stick" tampers or other approved hand-compacting equipment shall be used.

5. Jetting and Flooding methods are not permitted.

D. FLOWABLE BACKFILLING: In the pavement or sidewalk, curb and gutter sections on all existing City streets and State highways, flowable fill shall be used (unless otherwise approved by the City Engineer) for backfill and shall be in conformance with the standards of "Flowable Fill" as described herein. Flowable fill shall be discharged from the ready mix truck by any reasonable means into the trench to be filled. The fill will be brought up to the bottom of the surface course and shall be finished to provide a uniform surface. Care should be taken to prevent the flotation of any pipe.

VII. TRENCHES ON HIGHWAYS AND STREETS**:** Wherever trenches will be in, or must cross State highways or streets, the contractor shall obtain such excavation permits as are required for these crossings and shall become familiar with and abide by the rules and directions of the Utah Department of Transportation while working in these streets.

All contractors excavating in any Cedar City public right-of-way shall obtain a Road Breaking Permit in compliance with the Cedar City street ordinance prior to excavating.

All asphalt cuts shall be made with a diamond or carbide-tipped masonry or asphalt cutting saw or with a steel asphalt-cutting wheel attached to a grader or back-hoe. No scarifier-tooth cuts, back-hoe, bucket rips, or jackhammer spade cuts will be allowed.

All backfilled trenches in roadways shall be patched with hot-mix asphalt within fourteen days of initial excavation unless otherwise directed by the City Engineer. The backfill section shall be according to the typical road sections of these standards. All concrete or asphalt surfaces damaged or cut in trenching operations shall be restored to an as-good or better condition than prior to excavation in accordance with the provisions outlined in section 4.3 of these standards.

During the entire trenching, backfilling and patching operations, the Contractor will be required to observe all safety and traffic control procedures as outlined in these standards and City Ordinance Chapter 31.

The contractor shall be responsible for maintenance of the trench and patch for a period of 18 months from the date of the completion of the patching operation.

Unless otherwise approved by the City Engineer, not more than 400 feet of trench shall be left unfilled at any time in one continuous run.

All streets and roads trenched shall be kept free from dust and open to through traffic unless permission to close the street is obtained by the Contractor from the City Engineer. Up to one-half the width of any street or road shall be temporarily restored for use before excavation is commenced on the remaining portion of the street or road. All excavation, backfilling and temporary resurfacing on any portion of any street or road shall comply with the City Street Ordinance Chapter 31 and these standards.

VIII. CLEANING OF SANITARY SEWER LINES: After all sewer lines have been laid and the trench backfilled, the sewer lines shall be thoroughly cleaned prior to acceptance by the City.

Cleaning shall be accomplished by introducing sufficient water at the upper end of the trunks and laterals to flush the lines completely clean of all foreign material. No debris shall be permitted to enter any sewer lines in service. All debris shall be removed at the lowest manhole of the extension. Other methods of cleaning may be used, subject to approval by the City Engineer. After the lines have been thoroughly cleaned, they shall be tested between each manhole for displacement.

IX. CLEANING AND DISINFECTION OF WATER SYSTEMS: Each line, after being tested and before being placed in service, shall be disinfected by chlorination in accordance with AWWA standard C651-05. Prior to chlorination the entire line shall be flushed to insure that all dirt or foreign objects have been removed from the line. The line used to flush the line shall be six-inch minimum and no fire hydrants shall be used for flushing.

New water mains and extensions of existing mains shall be disinfected in accordance with AWWA standard C651-99. Sufficient chlorine shall be added to insure a residual of twenty-five parts per million in the water after twenty-four hours standing in the pipe. Chlorine calcium hypochlorite dry chlorinating chemical solution, containing approximately 65% available chlorine by weight, shall be used for this purpose. Calcium hypochlorite that is intended for swimming pool disinfection will not be allowed. The preferred method of disinfecting new water lines shall be continuous feed. Other methods within this standard may be allowed with permission and supervision of the process by the City.

Following chlorination, all treated water shall be drained and the pipeline thoroughly flushed with clean water. The entire line shall be flushed after the specified contact period, and such flushing shall be continued until the water is free from excess chlorine. The entire line, including hydrant laterals, branch lines, and dead-end mains shall be flushed. Chlorine residual must be tested after final flushing by the City Water Department. The discharge of flushed water shall be accomplished in such a manner that no erosion will occur and with no damage to streets or other property. Procedures for discharge will be subject to the review of the City Engineer and City Water Department.

X. SPARE CONDUIT LAYING, BEDDING AND BACKFILLING: Spare conduits shall be installed according to the typical utility trench detail.

4.2.3 QUALITY CONTROL. All underground pipelines shall be installed in accordance with these standards and tested as outlined below.

I. TRENCH BACKFILL MOISTURE/DENSITY TESTING.

Soil Proctor	One determination for each significant change in soil type as necessary to provide required compaction testing. Tests shall be ASTM D1557 Method A or D (modified proctor).
Trench backfill moisture/ density determination -	Tests are required for trench backfill for every 200 lineal feet of trench including service lateral trenches), or other utility trench or portion thereof, and each manhole, valve or set of valves within a 10-foot diameter that comes to the surface in the street section. Tests shall be run at the following trench elevations: One test at top of pipe zone. One test per 2 feet of depth measured from the bottom of the subgrade to the top of the pipe zone. Tests shall be evenly spaced vertically through the trench with one test at top of trench (bottom of subgrade). Additional testing may be required by the City Engineer or soils testing lab to verify compaction. Tests shall be according to ASTM D1556 or D2922 and D3017.

II. SANITARY SEWER LINE TEST AND ACCEPTANCE. This section specifies requirements for determining the acceptability of sewer systems after all sewer lines have been cleaned. The sewer lines, service laterals and manholes shall be tested for leakage and alignment in the presence of the City Engineer as outlined below. Where directed by the City Engineer and prior to acceptance by the City, the Contractor may be required to conduct and successfully pass a TV pipe inspection. Testing shall only be completed after installation of main lines, branch lines, and manholes. When indicated, below parts of this section shall also apply to storm drain systems.

A. DISPLACEMENT TEST. The displacement test shall be conducted by the Contractor in accordance with the following procedure:

A light shall be flashed between manholes or, if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the sewer or storm drain pipe shows broken, misaligned or displaced pipe, or other defects, the defects designated by the City Engineer shall be remedied by the Contractor. After cleaning and inspection have been completed, the sewer line shall be tested for leakage.

B. AIR TESTING. Each reach of sewer pipe to be tested shall be isolated by completely blocking all outlets in the section under test. Careful attention shall be given to blocking all plugs. Prior to installing the lower and upper plugs, concrete pipe and manholes shall be wetted to minimize any loss of air through the pipe or manhole walls as a result of permeability in the dry condition. One of the plugs used at the manhole must be equipped to control the air entry rate and to prevent the pressure from exceeding five p.s.i.g., this shall be done by means of a blow-off valve set to operate a five p.s.i.g.

After the concrete pipe has been wetted and plugs installed, the air shall be allowed to slowly fill the pipe until a constant pressure of 4.0 p.s.i.g. is maintained for at least two minutes. During the two-minute stabilization period, all plugs and exposed fittings shall be checked with a soap solution. If a leak is found, the air shall be bled off, the leak repaired and a new two-minute stabilization period begun. When the temperature of the air has reached equilibrium with that of the pipe wall, the air pressure shall be brought to 4 p.s.i.g. and the supply shall then be disconnected. When the pressure gauge reaches 3.5 p.s.i.g., a stop watch shall be started and then stopped when the pressure reaches 2.5 p.s.i.g. The time required as shown on the watch for a loss of 1 p.s.i.g. at an average pressure of 3.0 p.s.i.g. is used to calculate the rate of air loss. The pipeline may be considered to have passed the air loss test successfully if the loss of air is not greater than a rate of 0.0030 cubic feet per minute per square foot of internal pipe surface. The

following table shows the allowable time for the pressure to drop from 3.5 to 2.5 p.s.i.g. for respective pipe diameters.

Pipe Diameter	Time Min.	Sec.	Pipe Diameter	Time Min.	Sec.
6-inch	3	0	18-inch	8	30
8-inch	3	45	20-inch	9	30
10-inch	4	45	21-inch	10	0
12-inch	5	45	24-inch	11	15
14-inch	6	30	27-inch	12	45
15-inch	7	0	30-inch	14	0
16-inch	7	30	36-inch	17	0

C. EXFILTRATION TEST. In lieu of the standard sanitary sewer air test, the Contractor may make an exfiltration test in accordance with the following procedure:

The test section shall be blocked at both ends and the pipe subjected to a hydrostatic pressure produced by a head of water at a depth of three feet above the invert of the sewer at the upper manhole under test. In areas where ground water exists, the head of water shall be three feet above the existing water table. For concrete pipe, the three-foot head of water shall be maintained for a period of one hour to obtain full absorption of the pipe body and thereafter for a further period of one hour for the actual test leakage. For all other types of pipe, the three-foot head of water shall be maintained for a period of one hour only. During the one-hour test period the measured maximum allowable rate of ex-filtration for any section of sewer, including service stubs, shall be as listed below:

SEWER MAIN DIAMETER (inches)	MAXIMUM DROP IN HEAD IN A 4-FT. DIAMETER MANHOLE (Non-taper sect.) per 100 ft. of sewer pipe	MAXIMUM ALLOWABLE EXFILTRATION (Gallons/Hour/100 ft.)
6	0.1563 inch	1.2
8	0.2031 inch	1.6
10	0.2500 inch	2.0
12	0.3125 inch	2.4
15	0.3594 inch	2.8
18	0.4063 inch	3.2
21	0.4531 inch	3.6
21 or larger	0.5156 inch	4.0

In case measurements indicate an exfiltration greater than the maximum allowable leakage, additional measurements shall be taken and continued until all leaks are located and the necessary repairs and corrective work have reduced the leakage in the section being tested below the maximum allowable by these standards. For purposes of the test, the line between adjoining manholes will be considered a section and will be tested as such.

The Contractor shall furnish the plugs and other material and labor for placing the plugs in the sewer and shall assist the City Engineer in making all measurements required. The introduction of any substance into the water used for testing with the intent of sealing such leaks as may be indicated will not be permitted.

If results of either the air test or the exfiltration test is not satisfactory, repairs or pipe replacement shall be required until the City Engineer is satisfied that the leakage requirements are being met. All repair methods and materials used must be accepted by the City Engineer.

D. PVC AND HDPE DEFLECTION TEST. All PVC sanitary sewer pipe and when required by the City Engineer, PVC and HDPE storm drain pipe, shall be mandrelled with a rigid device sized to pass through the pipe with five-percent or less deflection of the pipe. These allowances shall include deformations due to all causes (wall thickness variations, shipping, production, backfill, heat, etc.). The mandrel device shall be cylindrical in shape and shall comply with the manufacturer's recommendations.

The mandrel shall be hand pulled by the contractor through all sewer lines. Any sections of sewer not passing the mandrel shall be uncovered and the contractor shall re-round or replace the sewer to the satisfaction of the City Engineer and all repaired sections shall be re-tested.

The deflection test shall be conducted after reaching final trench backfill grade and compaction.

E. INSPECTION AND FLUSHING. Prior to final acceptance of each section of sanitary sewer line, the Contractor shall flush all sewer lines. All dirt and debris shall be prevented from entering the existing sewer system by means of water-tight plugs or other suitable methods.

Upon completion of the project, the City Engineer will carefully inspect all sewers and appurtenances. Any unsatisfactory work shall be removed and replaced in a proper manner. The invert of the sewer and manholes shall be left smooth, clean, and free from any obstructions throughout the entire line. All manhole rings and covers shall be adjusted to finished grade and concrete collars installed prior to acceptance of the sewer system.

F. MANHOLE LEAKAGE TEST: Sewer manholes shall be tested for leakage prior to acceptance if they are located in areas of probable flooding or high water table, or if their tightness is suspect, as determined by the City Engineer. Allowable leakage shall be one gallon per hour per manhole. At least two manholes shall be tested, and based on these test and visual inspection of all manholes, additional tests may be required for other manholes. Any manhole, which tests unsatisfactorily, shall be repaired and retested until satisfactory results are obtained.

G. TELEVISION TESTING: When required by the City Engineer the Contractor or his representative (a qualified firm or individual agreed upon by the City Engineer and the Contractor) shall furnish labor, equipment, and materials, including camera and video tapes, and shall perform, in the presence of a City Representative, an internal television test of the completed sewer or storm drain pipe before it can be placed in service. Prior to the internal television test, the line being tested shall be flushed with clean water and allowed to free drain. The residual water shall not be removed in any way prior to the test. If all of the flushing water is removed, an amount of water shall be introduced into the farthest upstream manhole and will be allowed to flow through the newly installed pipes to expose potential low spots or "bellies". The contractor shall supply the City with a copy of the video tape. The television test shall be subject to the City Engineer's approval. Any defects in the pipe or the pipe installation noted on the internal TV inspection shall be corrected by the contractor and the repaired section shall be TV inspected after the repair to verify that the defective section has been corrected.

III. WATER SYSTEM TESTING AND ACCEPTANCE: The Owner and/or Contractor shall disinfect and test all water mains prior to final acceptance by the City. This shall include the owner repairing any existing parts of the City water system that must be included in the test but are not capable of holding test pressures. Or, as an alternative, testing the new water system before connecting it to the existing water system and having the City visually test the City approved connection of the systems. All concrete reaction blocks shall be in place at least five days before the initial filling of the line, unless high early strength concrete is used which will require three days in place.

A. PRESSURE TEST: After the pipe has been laid, including fittings, valves, corporation stops, services, and hydrants, and the line has been backfilled in accordance with these standards, each valved section, unless otherwise directed by the City Water Department, shall be subjected to hydrostatic pressure of not less than 200 pounds per square inch. The duration of each such test shall be two hours. Water added to maintain the pressure shall not exceed 0.4 gallons per inch diameter per 1000 lineal feet of main being tested during the two-hour test period.

Each valved section of pipe shall be slowly filled with water, and the specified test pressure measured at the lowest point of elevation. This shall be applied by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection, gauges, pipe caps and couplings, and all necessary apparatus shall be furnished by the Owner. Gauges and measuring devices must meet with the acceptance of the Water Department and the necessary pipe taps shall be made as directed. Before applying the specified test pressure, all air shall be expelled from the pipe by drilling small holes at points of highest elevations and afterward tightly plugging those holes with brass plugs.
Any cracked or defective pipes, fittings, valves, or hydrants discovered in the pressure test shall be removed and replaced with sound material in the manner provided. The test shall be repeated until the water main passes the pressure test and is accepted by the City Water Department or City Engineer.

B. OPERATIONAL INSPECTION: At the completion of the project and in the presence of the City Engineer, the Owner shall operate all valves, hydrants, and water services to ascertain that the entire facility is in good working order; that all valve boxes are centered and valves are operational; that all hydrants operate and drain properly and that water is available at all meter boxes.

IV. SPARE CONDUIT TESTING AND ACCEPTANCE: Spare conduits shall be accepted if the required nylon twine pull string with 500 pounds of pull strength can be blown through the conduit by attaching a plug to the pull string that fits tightly in the conduit and blowing the plug through the conduit with air pressure.

4.3 ROADWAY CONSTRUCTION This section covers the requirements for construction of roadway pavements including base course, bituminous prime coat, bituminous surface course, bituminous seal coat and street signs. Pavement structure shall comply with Table 4.3 unless required engineering and geotechnical studies support another preferable design.

TABLE 4.3
ROAD CROSS-SECTION STANDARDS

	TYPE OF ROAD	
	LOCAL AND COLLECTOR	MAJOR COLLECTOR AND ARTERIAL
ASPHALTIC CONCRETE	2.5"	3"
GRAVEL (ROADBASE)	6"	8"
TOTAL SECTION THICKNESS	8.5"	11"

4.3.1 MATERIALS: Roadway construction materials in City improvements shall conform to the following:

I. BASE COURSE MATERIAL: Base for all streets shall consist of select material, either pit run or road base. Prior to placing untreated base course, the Contractor shall submit, in writing, a job-mix gradation to the City Engineer for approval. The job-mix gradation shall have definite single values for the percentage of aggregate sizes.

A. PIT RUN: Pit run materials shall be deposited, spread and compacted on the scarified and compacted nature soil. The material used for Pit Run in all streets shall conform to the following:

1. Pit run shall consist of hard tough, and sound mineral aggregates that consist of native gravel free of deleterious and/or organic materials.

2. The gradation for the pit run material shall meet the gradation shown in Table 4.4.

TABLE 4.4
PIT RUN GRADATION

SIEVE SIZE	PERCENT PASSING (PIT RUN)
3"	100
2"	90-100
1"	70-90
3/4"	--
1/2"	50-75
3/8"	--
#4	30-65
#16	15-40
#50	--
#200	2-15

B. ROAD BASE MATERIAL**:** Road base material shall be deposited, spread and compacted on the finished Pit Run or scarified and compacted native soil as required. The supplier shall submit certification from a materials testing firm to the City Engineer for approval prior to the commencement of each construction season showing that the material used for Road Base conforms to the following:

1. Road base for all streets shall consist of clean, hard, tough, durable and sound mineral aggregates that consist of crushed stone, crushed gravel, or crushed slag; free of deleterious and/or organic materials.

2. Dry-rodded unit weight shall be at least 75 pounds per cubic foot.

3. Material shall meet fractured face minimum of 25% under UDOT 8-929, for material retained on the number 4 sieve and above.

4. Material-passing the number 40 sieve shall be non-plastic.

5. Aggregate wear under ASTM-C-131 or AASHTO T-96 shall be less than 50%.

6. The "Job Mix Target" gradation of the aggregate shall fall within the band limits shown on Table 4.5.

TABLE 4.5
ROAD BASE GRADATION

SIEVE SIZE	PERCENT PASSING OF TOTAL AGGREGATE (DRY WEIGHT)		
	1-Inch	3/4- Inch	1 ½ - Inch
1 ½ Inch	100	100	100
1 INCH	100	-	81-100
3/4 INCH	-	100	61-94
1/2 INCH	68-99	-	56-89
3/8 INCH	-	68-99	46-84
No. 4	40-70	46-76	33-72
No. 16	20-42	21-45	20-45
No. 200	4-14	4-14	4-14

II. BITUMINOUS PRIME COAT MATERIAL: The bituminous prime coat shall consist of an application of hot bituminous material on a previously prepared surface course. When required, bituminous material for the prime coat shall be MC-70.

III. BITUMINOUS SURFACE COURSE MATERIAL: Over the cured prime coat when required or over the prepared base course, the Contractor shall place and compact a bituminous surface course. The surface course shall consist of a mixture of materials of mineral aggregate and asphaltic cement. The bituminous surface course material supplier shall submit a mix design to the City Engineer for approval prior to the commencement of each construction season or upon selection of new aggregate sources.

A. AGGREGATE: The design mix gradation shall meet the specified gradations shown in Table 4.6 unless other job-mix designs are submitted and approved by the City Engineer prior to laying and conform to Table 4.9 of these Standards. The crushed aggregate shall have a weighted percent of loss not exceeding 10 percent by weight when subjected to five cycles of sodium sulfate and tested in accordance with AASHTO Designation T-104.

TABLE 4.6
BITUMINOUS SURFACE COURSE
AGGREGATE GRADATION

SIEVE SIZE	GRADATION LIMITS Percent Passing of Total Aggregate (Dry Weight)		
	3/4 inch Material	½ inch Material	3/8 inch Material (skin patches only)
1 Inch	-	-	-
3/4 Inch	100	-	-
1/2 Inch	-	100	-
3/8 Inch	70-95	-	100
No. 4	43-66	55-86	70-90
No. 8	-	-	45-70
No. 16	20-37	25-45	25-50
No. 50	10-25	10-25	10-25
No. 200	4-9	4-10	5-15

B. ASPHALTIC CEMENT MATERIAL: The asphaltic cement material shall be either AC-20 (AR-8000), AC-10 (AR-4000) or a performance grade asphalt binder (PGAB) PG 64-22 or PG 64-28 in accordance with the Asphalt-Institute specifications unless otherwise specified by the City Engineer. The percentage of asphaltic cement material or PGAB for ¾ and ½ inch aggregate material shall be according to the approved design mix. This percentage can deviate by 0.3% from the target. The percentage of Asphaltic Cement material or PGAB for 3/8 inch skin patch aggregate material shall be 6%. This percentage can deviate by 0.5% from the 6%.

C. RECLAIMED ASPHALT PAVEMENT (RAP): A maximum of 15% of RAP as a percent by weight of RAP to the total weight of the mix will be allowed for bituminous surface course material.

IV. BITUMINOUS SEAL COAT MATERIAL: (ASPHALT EMULSION/FLUSH COAT) Bituminous surface treatment (Flush Coat) shall be applied to the road surface of all new streets and other existing streets when required by the City Engineer. The bituminous surface treatment shall consist of an application of asphalt emulsion over the bituminous surface course. The materials used in the application of the bituminous surface treatment shall be asphalt emulsion and blotter sand when required. The materials for this seal coat are as follows:

A. ASPHALT EMULSION: The asphalt emulsion shall conform to the specifications outlined in Table 4.7.

B. BLOTTER SAND shall consist of pit reject sand with no particle larger than 1/8 inch.

TABLE 4.7
ASPHALT EMULSION TEST SPECIFICATIONS

T E S T S O N E M U L S I O N S				
TESTS	TEST METHOD		TYPE OF EMULSION	
	AASHTO	ASTM	ANIONIC	CATIONIC
			QUICK SETTING	QUICK SETTING
			CQS-H	CQS-KH
Dilution Rate: Part Oil: Part Water			2:1	2:1
PARTICLE CHARGE TEST	- -	D244, 18-20	NEGATIVE	POSITIVE
FUROL VISCOSITY, 60 ml., @ 77 Deg. f., 5 Seconds	T59, 2b1	D88	15 to 50	
RESIDUE BY EVAPORA-TION	T59, 2a3	D244, 13-17	60 Percent by weight, minimum	
SETTLEMENT AFTER FIVE DAYS	T59, 2c2	D244, 28-31	3 Percent maximum	
SIEVE TEST	T59, 2c4	D244, 37-40	0.10 Percent maximum	- - - - - - - -
SIEVE TEST	------	D2397 4.1.2	_____	0.10 % max.
CEMENT MIXING TEST	T59, 203	D244, 32-36	2% Maximum	Not Applicable

V. BITUMINOUS SEAL COAT MATERIALS: (CHIP SEAL) Bituminous surface treatments (chip seals) shall be applied to the road surface only when required or approved by the City Engineer. The bituminous surface treatment shall consist of an application of bitumen covered with mineral aggregate and rolled to a smooth surface presenting an even texture, then coated with asphalt emulsion. The materials used in the application of the bituminous surface treatment shall be bituminous mineral, mineral aggregate, and asphalt emulsion specified as follows:

A. BITUMINOUS MATERIAL: The bituminous material shall be cationic emulsified asphalt (type CRS-LM {Latex Modified}), with a Saybolt Furol viscosity (at 122 degrees Fahrenheit) of between 300 and 400 seconds, and shall conform to the requirements as outlined in AASHTO Designation M208. The bituminous material shall also conform to the following requirements:

1. Sieve limit of 0.10 percent.

2. The particle charge shall be positive.

3. The Residue by evaporation shall be 65 percent by weight, minimum.

4. The results of the test on residue from distillation (tested in accordance with ASTM D-244) shall be as follows:

TESTS	MINIMUM	MAXIMUM
Penetration	100 mm.	250 mm.
Ductility	40 cm.	100 cm.
Solubility in Trichloroethylene	97.5%	100%

B. AGGREGATE (CHIPS): Mineral aggregate shall consist of crushed stone or crushed gravel, free from adherent films of clay or dust, and shall be of such nature that a thorough coating of the bituminous material used in the work will not strip off upon contact with water.

The gravel or rock shall have a percent of wear not greater than 30 when tested by the Los Angeles Abrasion Test (AASHTO T-9 ASTM C 131). Aggregate shall be cubical or pyramidal in shape with at least 85% fractured faces.

Stripping tests of the mineral aggregate, which the Contractor proposes to use, shall be furnished to the City Engineer before crushing operations begin. During the crushing of the aggregate, additional stripping tests shall be furnished to the City Engineer upon request. No stripping test shall show a percent stripping greater than 10 for CRS-2 asphalt. The chip shall be electrically compatible to the asphalt emulsion used.

The crushed aggregate shall conform to the gradation requirements shown in table 4.8.

TABLE 4.8
GRADATION OF AGGREGATE FOR CHIP SEAL COATS

SIEVE SIZE	PERCENT BY WEIGHT PASSING (Ideal)	
	TYPE I	TYPE II
1/2 Inch	100	
3/8 Inch	70-100	
No. 4	0-20	100
No. 8	0-5	0-15
No. 200	0-2	0-1

The initial mineral aggregate used for the production of chips shall be retained on a 5/8 inch sieve prior to being crushed to the gradation specified.

C. ASPHALT EMULSION: See Section 4.3.1 IV

VI. STREET SIGN MATERIALS: Street sign materials shall conform to the following standards with the dimensions as indicated in the standard drawings:

A. ALUMINUM SIGN BLANKS: The aluminum sign blanks shall be either sheet or extrusion aluminum, 0.080 inch thick for 6-inch blanks and 0.10-inch thick for 9-inch blanks, ASTM B209 Alloy 6061-T6 or 6063-T5 and 6063-T6.

B. SIGN POSTS: Sign post shall be galvanized, 3/32 inch structural steel, ASTM A36, 1.75 inch square, perforated with 3/8 inch diameter holes, 1 inch on center on all four sides.

C. MOUNTING SLEEVES: Mounting sleeves shall be the same as the sign post except 2 inch square.

D. REFLECTIVE SHEETING: Sign reflective sheeting shall be Class 4 for all background, letters, numerals, symbols, borders and accessories.

E. SIGN HARDWARE: All sign hardware shall be galvanized, ASTM A307 steel dimensioned according to the standard drawings.

F. SIGN COLORS AND FORMAT: Sign colors and format shall conform to ANSI D6.1 and The Manual on Uniform Traffic Control Devices.

4.3.2 CONSTRUCTION METHODS AND EQUIPMENT: The methods employed in performing the work and all equipment, tools and machinery and other appliances used in handling the materials and executing the work shall be the responsibility of the Contractor. The Contractor shall make such changes in the methods employed and in the equipment used as are necessary whenever the road construction materials that are being installed do not meet the specifications herein established.

I. PIT RUN CONSTRUCTION METHODS AND EQUIPMENT: The methods employed in installing Pit Run shall include but not be limited to the following:

A. When mixing and placing, the moisture content of the pit run shall be maintained at optimum, when tested, plus or minus 2%.

B. When placing, the layers shall be of equal thickness not to exceed 6" in thickness.

C. Do not place Pit Run on frozen subgrade or native material.

D. Do not place additional material on any unacceptable layer.

E. Material shall be deposited and spread in uniform lifts not to exceed six-inch compacted thickness, without segregation of size. When compacted, the Pit Run shall meet the required thickness.

F. Each layer shall be compacted for the full width and depth by rolling with a pneumatic roller weighing at least 10 tons. Alternate blading and rolling will be required to provide a smooth, even and uniformly compacted course true to cross-section and grade. Places inaccessible to rolling shall be compacted with mechanically operated hand tampers. The Pit Run shall be compacted to not less than 95% maximum dry density as determined by ASTM D-1557.

G. Surfaces shall be true to the established grade with thickness varying not more than 1 inch from the required layer thickness. Finish grade shall be established with hubs placed at 50-foot maximum spacing on centerline and shoulders.

II. ROAD BASE CONSTRUCTION METHODS AND EQUIPMENT: The methods employed installing road base shall include but are not limited to the following:

A. When mixing and placing, the moisture content of the untreated base course shall be maintained at optimum, when tested, plus or minus 2%.

B. When placing, the layers shall be of equal thickness not to exceed 6" in thickness.

C. Do not place road base on frozen subgrade, sub-base or on a frozen layer of road base. No road base shall be installed from November 1st to April 1st unless approved by the City Engineer.

D. Do not place additional material on any unaccepted layer.

E. Material shall be deposited and spread in uniform lifts not to exceed six-inch compacted thickness, without segregation of size. When compacted, the Road Base shall meet the required thickness.

F. Each layer shall be compacted for the full width and depth by rolling with a pneumatic roller weighing at least 10 tons. Alternate blading and rolling will be required to provide a smooth, even and uniformly compacted course true to cross-section and grade. Places inaccessible to rolling shall be compacted with mechanically operated hand tampers. The Road Base shall be compacted to not less than 95% maximum dry density as determined by ASTM D-1557.

G. Surfaces shall be true to the established grade with thickness varying not more than 1/4 inch from the required layer thickness. Finish grade shall be established with hubs placed at 50-foot maximum spacing on centerline and shoulders.

III. BITUMINOUS PRIME COAT CONSTRUCTION METHODS: The methods employed in installing Bituminous Prime Coat shall include but are not limited to the following:

A. PREPARATION: Immediately prior to the application of the prime coat, all loose material, dirt, clay, or other objectionable material, shall be removed from the surface to be primed. After the cleaning operation, and prior to the application of the prime coat, the surface shall be steel rolled and lightly sprinkled with water immediately in advance of the application as directed by the Engineer, to assure a uniform spread of the bituminous material.

B. APPLICATION: Immediately following the preparation of the base course, the bituminous prime material shall be applied at the rate of .25

gallon per square yard of surface course by means of a bituminous distributor at the temperature specified. The asphalt distributor shall be equipped with a calibrated dipstick marked in gallons per inch of length, and an accurate thermometer and speedometer. The distributor shall also be able to maintain the correct pump speed of pressure without either atomizing the asphalt or distorting the spray fan. However, the pump shall be able to maintain a pressure that shall be sufficient to prevent streaking from a non-uniform discharge of material from the individual nozzles.

The asphalt distributor shall be equipped with a rear mounted spray bar capable of covering widths of 6 to 15 feet in a single pass. The distributor tank shall be well insulated and be equipped with one or more heaters capable to bringing the asphalt material to spray application temperature. The tank shall have a full circulating system with an engine-driven pump. The circulating system shall include the spray bar unit. The truck shall also be equipped with a hand-spray for applying the asphalt material to areas that cannot be reached with the spray bar.

The distributor shall be equipped with charts for determining the discharge for each nozzle's size, the proper truck speeds for various application rates, and the correcting of temperature-viscosity variations. The operator of the asphalt distributor shall be capable of applying the material as specified. If the operator is incapable of performing the work, at the request of the City, he/she shall be removed.

C. CURING: Following the application of prime material, the surface shall be allowed to dry for a period of not less than 48 hours without being disturbed, or of such additional period of time as may be necessary to attain penetration into the foundation course and drying out or evaporation of the volatiles from the prime material, which period shall be determined by the City Engineer. The Contractor shall furnish and spread sufficient approved sand on all areas that show an excess of bituminous material to effectively blot up and cure the excess, as directed by the City Engineer. The primed surface shall be maintained by the Contractor, and he/she shall repair all broken spots.

D. WEATHER LIMITATIONS: Bituminous material for the prime coat shall only be applied when the minimum temperature of the air or road bed is 50 degrees and rising. Application conditions shall be subject to the discretion of the City Engineer.

IV. BITUMINOUS SURFACE COURSE CONSTRUCTION METHODS AND EQUIPMENT: The methods employed in installing Bituminous Surface Course shall include but are not limited to the following:

A. MIXING: The bituminous surface course shall be mixed at a mixing plant and spread and compacted on the prepared base in conformance with the lines and dimensions shown on the plans and in accordance with these Standards.

The combined mineral aggregate plus any specified additives when mixed with the specified bituminous binder in accordance with ASTM Designations D-6926 and D-6927 shall conform to the requirements shown in Table 4.9.

TABLE 4.9
BITUMINOUS SURFACE COURSE SPECIFICATION

Marshall stability	1200 pounds minimum
Flow (0.01 inch)	10-18
Voids Content	2% to 4%
Los Angeles Abrasion Test	30% Max. loss in 500 revolutions
Fractured face	75% min.
Asphalt Content	According to approved design mix ∀ 0.3%.
RAP Content	15% maximum of total mix weight

B. SPREADING: The bituminous mixtures shall be spread with self-propelled mechanical spreading and conditioning equipment capable of distributing at least a 12-foot width. The spreader shall be equipped with an automatic leveling screed. The mixture shall be spread and struck off in such a manner that the finished surface will result in a uniform smooth surface. The longitudinal joints in succeeding courses shall be off-set at least 12 inches vertically to avoid a vertical joint through more than one course. All transverse joints shall be offset from one another at least four feet longitudinally, except as required by the City Engineer. The temperature of the bituminous mix shall be between 250 degrees and 325 degrees F. when placing. When the thickness of the bituminous surface course is four or more inches, it shall be installed in two or more lifts or courses. The top lift of that bituminous surface course shall be at least 2 inches thick. The ½ inch material for aggregate shall be used in the bituminous surface course for the top lift of a multi-lift installation and the one lift for a single lift installation.

C. COMPACTION: After the mixture has been spread, the surface shall be rolled in longitudinal direction commencing at the outside edge or lower side and proceeding to the higher side. Each pass of the roller shall overlap the

preceding pass at least one-half the width of the roller. Rolling shall continue until 96% of the laboratory bulk density has been obtained. Rolling operations shall be conducted in such a manner that shoving or distortion will not develop beneath the roller. The surface of the pavement, after compaction, shall be uniform and true to the established crown and grade. All traffic shall be kept off the surface until rolling is completed.

D. TEMPERATURE LIMITATIONS: No bituminous surface course shall be placed when the temperature of the air or road bed is 50 degrees F. or below; during rainy weather; when the base is wet; during the period from November 1st through April 1st or during other unfavorable conditions as determined by the City Engineer. However, minor repairs will be allowed during winter months. The air temperature shall be measured in the shade. The temperature of the bituminous mix shall be between 250 degrees and 325 degrees F. when placing.

V. BITUMINOUS FLUSH COAT CONSTRUCTION METHODS: The methods employed in installing Bituminous Flush Coat shall include but are not limited to the following:

A. SURFACE PREPARATION: he Contractor shall thoroughly remove all dust, dirt, tracked on clay and foreign material from the surfaces to be sealed by sweeping the surface with power brooms, hand brooms, power blowers, or by flushing it with water or a combination of the above. All patching, crack filling and drainage improvements shall be completed prior to the commencement of the surface treatment project.

After the cleaning operation has been completed, and prior to the application of the surface treatment, the area to be treated will be inspected by the City Engineer to determine its fitness for receiving the surface treatment.

B. EMULSION APPLICATION: Anionic emulsion shall be used and shall be applied at the rate of 0.08 to 0.20 gallons per square yard as determined by the City Engineer. The asphalt emulsion shall be diluted at the rate of 1:1 with potable water. An asphalt distributor conforming to Section 4.3.2.III.B shall be used to apply the emulsion at the specified temperature. The emulsion shall not be placed within 3 days after new bituminous surface course has been laid. The emulsion shall all be placed 7 days prior to any striping of the bituminous surface course.

C. BLOTTING: Any excess emulsion that does not cure after 2 hours shall receive a covering of blotter sand.

D. WEATHER LIMITATION: The flush coat shall be placed only when the air temperature in the shade and the road bed temperature are above 50

degrees F. The flush coat shall not be placed when the temperature of the road surface is above 130 degrees F., during rainy weather, when the road is wet or during other unfavorable weather conditions as determined by the City Engineer.

VI. BITUMINOUS CHIP SEAL CONSTRUCTION METHODS: The methods employed in installing Bituminous Chip Seal shall include but are not limited to the following:

A. SURFACE PREPARATION: The Contractor shall thoroughly remove all dust, dirt, tracked on clay and foreign material from the surfaces to be sealed by sweeping the surface with power brooms, hand brooms, power blowers, or by flushing it with water or a combination of the above. All patching, crack filling and drainage improvements shall be completed prior to the commencement of the surface treatment project. After the cleaning operation has been completed, and prior to the application of the surface treatment, the area to be treated will be inspected by the City Engineer to determine its fitness for receiving the surface treatment.

B ASPHALT APPLICATION: The asphalt material shall be applied at 0.40 to 0.60 gallon per square yard as determined by the City Engineer and at a temperature between 125 degrees to 185 degrees Fahrenheit. The exact temperature used to apply the bituminous material shall be determined by the City Engineer. Application of the asphalt shall not be permitted to begin until the loaded aggregate trucks are in place and ready to apply the cover aggregate. The bituminous material shall be applied by an asphalt distributor as described in Section 4.3.2.III.B so that uniform distribution in the quantities specified is obtained over all points of the surface to be treated.

All lightly-coated areas and spots missed by the distributor shall be properly treated with bituminous material applied by hand. No more asphalt shall be applied than can be covered with aggregate in 30 seconds or less. Distances between the distributor and chip-spreader shall be as close as possible, but in no case shall the chip-spreader be greater than 50 feet behind the distributor during the chipping operations.

C. AGGREGATE SPREADING: Immediately following the application of the bituminous material, the aggregate shall be evenly spread at a uniform quantity of 15 to 20 pounds per square yard of surface area. Upon commencement of the work, and during its progress, the individual quantities of bitumen and aggregate may be varied to meet specific field conditions, as directed by the City Engineer. An adequate supply of aggregate shall be available on the job site to permit continual spreading operations. The aggregate shall be spread by using a self-propelled spreader (Farity or equal). The aggregate shall be spread evenly by hand on all areas missed by

the aggregate spreader. Back-spotting or sprinkling of additional aggregate over the areas having insufficient cover shall be done by hand and shall be continued during the operations whenever necessary.

As the distributor moves forward to spray the asphalt, the aggregate spreader shall start right behind it, spreading the chips uniformly and at the specified rate. The asphalt distributor shall travel at the same rate of speed as the chip spreader and in no case shall the two machines be separated by more than 50 feet during the sealing process. Operating the chip spreader at speeds that cause the chips to roll over after striking the bituminous-covered surface will not be permitted.

D. AGGREGATE COMPACTION: Excess aggregate deposited in localized areas shall be immediately removed with square-end shovels, and in areas where application is insufficient, additional aggregate shall be added by hand. The treated surface shall be rolled with rubber-tired rollers immediately after the distribution of the cover aggregate, and shall continue until the aggregate is properly seated in the binder. Rollers shall proceed in the longitudinal direction, working across the treated surface until the entire width and length of the treated surface has been rolled at least four times. Rollers and gravel trucks shall not be operated at speeds great enough to kick up chips, and in no case shall rollers be operated above 10 miles per hour. In all places not accessible to the rollers, the aggregate shall be adequately compacted with hand tampers. Any aggregate that becomes coated or mixed with dirt or any other foreign material shall be removed, replaced with clean aggregate over a newly-sprayed surface, and then re-rolled as directed by the City Engineer. Bituminous material and chips shall not be spread more than 100 feet ahead of completion of initial rolling operations. To eliminate excessive ridging, all joint edges shall be swept prior to the application of the second course of aggregate on double chip seal treatments.

E. LOOSE AGGREGATE REMOVAL: Upon completion of rolling, traffic will be allowed to use the streets at a speed not to exceed 15 miles per hour for a period of not less than 24 hours. After the chips are set in the bituminous binder, but not earlier than the following day, any loose chips forming corrugations shall be distributed over the surface. At the end of seven days, any excess chips shall be removed in such a manner that the aggregate set in the binder will not be displaced. Excessive rolling or brooming will not be permitted.

F. ASPHALT EMULSION APPLICATION: Asphalt emulsion "Flush Coat" shall then be applied to the finished, chipped surface according to Section 4.3.2.V.

G. MISCELLANEOUS CLEAN UP: After the surface has been opened to

traffic, any excess bituminous binder that comes to the surface shall be immediately covered with additional chips or clean sand. The completed surface shall present a uniform appearance and shall be thoroughly compacted and free from ruts, humps, depressions or irregularities due to an uneven distribution of bituminous binder or chips.

H. WEATHER LIMITATIONS: The chip seal shall be placed only when the air temperature in the shade and the road bed temperature are above 75 degrees F. The chip seal shall not be placed when the temperature of the road surface is above 130 degrees F., during rainy weather, when the road is wet or during other unfavorable weather conditions as determined by the City Engineer.

VII. STREET SIGN INSTALLATION METHODS: Street signs shall be installed as follows and placed according to the standard drawings:

A. Posts shall be installed in the post sleeve that is driven plumb into compacted earth.

B. All joints shall be cut flat and true.

C. Connections shall be tight.

D. Sign faces shall be cleaned and in the proper orientation.

4.3.3 QUALITY CONTROL: Roadway Construction in City improvements shall have the minimal testing and acceptance standards as follows and conform to the requirements outlined in Section 1.4 of these standards.

I. BASE COURSE QUALITY CONTROL: All base course (both pit run and road base materials) shall be placed in accordance with these standards, and tested and accepted as follows:

A. TESTING: Minimum testing of the base course shall be as follows:

Gradation Tests:	One test per 15,000 sq. feet of roadway surface area or fraction thereof. The sieve analysis shall be according to ASTM C136, C117. Care shall be exercised in sampling where both 1-inch and 3/4-inch base course has been used so blending does not occur.
Soil Proctor:	One determination for each source of base course as necessary to provide required

compaction testing. Tests shall be according to ASTM D1557, Method A or D (modified proctor).

Moisture/
Density Tests: One test per 7,000 sq. feet of roadway surface area or fraction thereof. Moisture content shall be at optimum plus or minus 2 percent for test to pass and shall be maintained until prime coat or asphalt is applied. Tests shall be according to ASTM D1556 or D2922 and D3017.

Thickness: One random boring or test hole per 5,000 sq. feet of surface area or fraction thereof to verify required thickness. If sufficient inspection has been made by a City Engineer to verify required thickness, the City Engineer may waive thickness testing.

No single measured thickness shall be less than the required design thickness.

Testing documentation shall be according to Section 2.4 of these standards.

B. ACCEPTANCE: Any base course determined not to be in compliance with these standards shall either be removed and replaced or re-worked until compliance is obtained. Any costs for testing re-work shall be paid for by the developer.

II. BITUMINOUS SURFACE COURSE QUALITY CONTROL: All bituminous surface course shall be placed in accordance with these standards and tested as follows:

A. TESTING. Minimum testing of the bituminous surface course is as follows:

Material
Certification: Each project shall submit independent written certification through the material supplier that surface course materials comply with these City standards.

All material certification tests shall be according to

ASTM D1559 (modified).

Certification for a material source previously approved for the current construction season will be acceptable provided sources of the individual components of the combined surface course mix have not changed.

Extraction-Gradation Test:	One test per 500 tons of material placed or one per day whichever is more. Tests shall be according to UDOT test procedures 8-946 and 8-947.
Field Density Tests:	One test per 7,000 sq. ft. of surface area or fraction thereof. Tests shall be according to ASTM D2950.
Thickness Tests:	One core sample from each section of 10,000 sq. ft. or fraction thereof. At the discretion of the City Engineer, thickness testing may be waived for material placed in public roadway construction if sufficient inspection has been made by the City Engineer to verify required thickness.

Testing documentation shall be according to Section 2.4 of these standards.

B. ACCEPTANCE: Any bituminous surface course determined not to be in compliance with these standards shall either be removed and replaced or re-worked until compliance is obtained. Any costs for testing re-work shall be paid for by the developer.

III. BITUMINOUS FLUSH COAT QUALITY CONTROL: All bituminous flush coat material shall be placed in accordance with these Standards and certified as follows:

Material Certification:For each job, the supplier shall submit a report from a certified testing laboratory that the Asphalt Emulsion conforms to these City Standards.

IV. BITUMINOUS CHIP SEAL QUALITY CONTROL: All bituminous chip seal materials (CRS-2 and chips) shall be placed in accordance with these Standards and certified as follows:

Material Certification:Each job shall submit independent written certification through the material supplier that both the bituminous material and aggregate comply with these City Standards.

4.4 CONCRETE WORK: This section of the Standards defines the materials to be used and the requirements for mixing, placing, finishing and curing all Portland cement concrete work on public improvements within Cedar City. The concrete supplier shall submit a mix design for both classes of concrete and flowable fill to the City Engineer for approval prior to the commencement of each construction season or upon a change in the aggregate source or other materials in the mix. The mix design shall include all additives proposed to be used. Material information sheets shall be provided for all additives.

4.4.1. MATERIALS. Concrete construction materials in City improvements shall conform to the following requirements:

I. PORTLAND CEMENT CONCRETE MATERIAL: The concrete shall be composed of coarse aggregate, fine aggregate, Portland Cement and water, and shall conform to the following requirements:

A. PORTLAND CEMENT: ANSI/ASTM C 150, Type I, low alkali, unless otherwise indicated, or acceptable to the City Engineer.

Use Type II or Type V cement for concrete that will be in contact with soil, excluding floor slabs.

Use one brand of cement throughout project, unless otherwise acceptable to City Engineer.

B. AGGREGATES. Except as otherwise specified herein, concrete aggregates shall conform to all applicable provisions of the latest revision of ASTM Standard Specification C 33.

1. Fine Aggregate: Fine aggregate shall consist of natural sand or, subject to approval, other inert materials with similar characteristics, having clean, hard, durable, uncoated grains and shall conform to the requirements of these standards. The amount of deleterious substances shall not exceed the following limits:

MATERIAL	PERCENT (by weight)
Clay Lumps	1.00
Coal and lignite	0.50
Material passing No. 200 sieve	3.00
Other deleterious substances such as shale, alkali, mica, coated grains, soft and flaky particles, etc.	3.00

The sum of the percentage of all deleterious substances shall not exceed five percent by weight.

Fine aggregate shall be well graded and shall range in size from fine to coarse within the following percentages by weight:

SIEVE SIZE	PERCENT PASSING (by weight)
3/8 inch	100
No. 4	95-100
No. 8	80-90
No. 16	50-75
No. 30	30-50
No. 50	10-20
No. 100	2-5

3. Coarse Aggregate: Coarse aggregate shall consist of crushed stone, gravel, slag or other approved inert material with similar characteristics or combination thereof, having clean, hard, durable, uncoated particles free from deleterious matter. Deleterious substances shall not be present in the aggregate in excess of the following limits:

MATERIAL	PERCENT (by weight)
Soft fragments	2.00
Coal and lignite	0.30
Clay Lumps	0.25
Material passing No. 200 sieve	1.00
Other deleterious substances such as shale, alkali, mica, coated grains, soft and flaky particles, etc.	3.00

The sum of the percentages of all deleterious substances in any size or delivered to the mixer, shall not exceed five percent (5%), by weight.

Coarse aggregate may be rejected if it fails to meet the following test requirements:

a. Los Angles Abrasion Test: If the percent of loss by weight exceeds ten percent at 100 revolutions, or forty percent at 500 revolutions.

b. Sodium Sulfate Test for Soundness: If the weighted average loss after five cycles is more than twelve percent by weight.

c. Gradation: Coarse aggregate shall be graded by weight as follows:

SIEVE SIZE	PERCENT PASSING (by weight)
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No. 4	0-10
No. 8	0-5

The maximum size of the aggregate shall be not larger than one-fifth of the narrowest dimension between forms within which the concrete is to be incased, and in no case larger than three-fourths of the minimum clear spacing between reinforcing bars or between reinforcing bars and forms. For un-reinforced concrete slabs, the maximum size of aggregates shall not be larger than one-fourth the slab thickness.

C. WATER. Sufficient potable water shall be added to the mix to produce concrete with the minimum practical slump, and in no case shall the slump be greater than 4 inches.

The maximum permissible water-cement ratio (including free moisture in the aggregate) shall be 5 gallons per bag of cement (0.44) for Class A and 5 3/4 gallons per bag of cement (0.51) for Class C concrete. If Pozzolan is added to the concrete mix the weight of the pozzolan shall be added to the cement weight to determine the water-cement ratio.

D. ENTRAINING AGENT. An air-entraining agent shall be used in all concrete exposed to the weather. The agent shall conform to ASTM designation C 260. Air content for air-entrained concrete shall be 5% by volume (plus or minus 1%). The air-entraining agent shall be added as a liquid to the mixing water by means of mechanical equipment capable of accurate measurement and control.

E. ADMIXTURES.

1. Pozzolan. 20% maximum of the concrete mix cement weight may be replaced with pozzolan conforming to the requirements of ASTM C 618 Class N and AASHTO M295.

Pozzolans shall be sampled and tested as prescribed in ASTM C 618 and ASTM C 311. The contractor shall obtain and deliver to the City Engineer a certification of compliance signed by the Pozzolan supplier identifying the Pozzolan and stating that the Pozzolan delivered to the batching site complies with applicable specifications.

Pozzolan material shall be handled and stored in the same manner as Portland cement. When facilities for handling bulk Pozzolan are not available, the Pozzolan shall be delivered in original unopened sacks bearing the name and brand of supplier, the type and source of the Pozzolan, and the weight contained in each sack plainly marked thereon.

Different brands or types of pozzolan shall not be mixed together

unless written permission has first been obtained from the City Engineer. All Pozzolan used in the manufacture of concrete for any individual structure shall be of the same type, and from the same source unless otherwise approved by the City Engineer.

2. Calcium Chloride. No calcium chloride shall be added to any concrete mix. Non-chloride accelerators may be used with permission of the City Engineer.

F. CONCRETE MIX. For the purpose of practical identification, concrete has been divided into classes. The basic requirements of class A, B and class C and the use for each is defined in Table 4.10.

TABLE 4.10
CONCRETE MIX SPECIFICATIONS

CLASS	MINIMUM CEMENT CONTENT		MAXIMUM WATER CONTENT (gal./bag of cement)	MAXIMUM SLUMPS	MINIMUM 28-DAY COMP. STRENGTH (psi)	PRIMARY USE
	(Bags/ C.Y.)	(pounds/ C.Y.)				
A	7	658	4.43	4”	5000	Cross Gutters
B	6	564	5	4" 2"*	4000	Reinforced structural concrete; side-walks; curbs & gutters; cross gutters; pave-ments; unrein-forced footings
C	5	470	5.75	4"	3000	Minor non-structural items such as thrust blocks; anchors, mass concrete, etc.

Unless specifically waived by the City Engineer all concrete placed shall be Class "A", six-bag mix, and the minimum allowable compressive strength of concrete at the age of 28 days shall be 4000 p.s.i.
* For machine placement, sections should not deform.

II. CONCRETE REINFORCING MATERIALS. Concrete reinforcing materials shall conform to the following:

A. STEEL BARS. All bar material used for reinforcement of concrete shall be intermediate or hard grade steel conforming to the requirements of ASTM Designation A 615 and shall be deformed in accordance with ASTM Designation A 615. All reinforcing steel shall be minimum grade 60 unless approved otherwise by the City Engineer.

All bars shall be deformed-round and have a net section equivalent to that of plain bar of equal nominal size. Only intermediate and/or hard grades will be used and no twisted bars will be accepted.

All reinforcing steel, at the time concrete is placed, shall be free from flaws, cracks, mill scale, rust, oil, dirt, paint, (unless epoxy coated) or other coatings that will destroy or reduce the bond.

B. WIRE OR WIRE MESH REINFORCEMENT. Welded wire fabric for concrete reinforcement shall conform to the requirements of ASTM A 185. Wire for concrete reinforcement shall conform to the requirements of the "Standard Specification for Cold Drawn Steel Wire for Concrete Reinforcement" ASTM A 82. All wire reinforcement, wire mesh, or expanded metal shall be of the type designated unless an alternate type is approved by the City Engineer.

C. STEEL FIBER REINFORCEMENT. Deformed steel fiber for concrete reinforcement shall conform to the requirements of ASTM A 820, type I, deformed fiber, except that the average tensile strength shall be not less than 150,000 psi.

D. ENGINEERED SYNTHETIC REINFORCING FIBERS. Engineered synthetic reinforcing fibers shall be 100% polypropylene collated, fibrillated fibers. Fiber length and amount per manufacturer's recommendations shall correspond with the concrete mixture.

Physical properties of the fibers shall be as follows:

Specific gravity	0.91
Modulus of elasticity	500,000 to 700,000 psi
Tensile strength	70,000 to 110,000 psi
Length	0.25 to 2.50 inches

The fiber manufacturer shall certify that all polypropylene fibers meet the physical properties, and are specifically manufactured for use in concrete from virgin polypropylene, containing no reprocessed olefin materials. If the fiber manufacturer is other than the brand name listed on the literature and packaging, the certification must be from the original manufacturer of the fibers.

III. CONCRETE BASE MATERIALS: Concrete base materials shall conform to the following:

A. SUBGRADE: The subgrade shall be excavated and filled with suitable material as specified in Section 4.1.2 of these standards to within six inches of the required grades for curbs and gutters, waterways, driveways, and sidewalks. All soft, yielding and otherwise unsuitable material shall be removed and replaced with suitable materials as outlined above. Filled sections shall be compacted and extend to a minimum of one foot outside the form lines according to Section 4.1.3. III of these standards.

B. GRAVEL BASE COURSE. A gravel base course consisting of 3/4" maximum crushed road base gravel six-inches thick shall be placed under all curbs, gutters, driveways, waterways and sidewalks. Where the foundation material is found to be unstable, the Contractor shall furnish and place sufficient extra gravel fill as directed by the City Engineer to firm up the soil upon which the curb, gutter and sidewalk is to be placed.

4.4.2. CONSTRUCTION METHODS & EQUIPMENT: The methods employed in performing the work, all equipment, tools and machinery, and other appliances used in handling the materials and executing the work shall be the responsibility of the Contractor. The Contractor shall make such changes in the methods employed and in the equipment used as are necessary whenever the concrete being installed does not meet the specifications herein established. These methods shall include but not be limited to:

I. GENERAL CONCRETE PLACEMENT: Generally concrete shall be installed as follows:

A. FORMS. Forms shall be substantially built and adequately braced so as to withstand the liquid weight of concrete. All linings, studding, walling and bracing shall be such as to prevent bulging, spreading, or loss of true alignment while pouring and displacement of concrete while setting.

B. PREPARATIONS. Before batching and placing concrete, all equipment for mixing and transporting the concrete shall be cleaned, all debris and ice shall be removed from the places to be occupied by the concrete, forms shall be oiled with a form-release agent, and masonry filler units that will be in contact with concrete shall be well drenched with water (except in freezing

weather), and the reinforcement shall be thoroughly cleaned of ice or other coatings. Water shall be removed from spaces to receive concrete.

When placing concrete on earth surfaces, the surfaces shall be free from frost, ice, mud and water. When the subgrade is dry soil or pervious material, it shall be sprayed with water prior to the placing of concrete or shall be covered with water-proof sheathing paper or a plastic membrane. No concrete shall be placed until the surfaces have been inspected and approved by the City Engineer.

C. CONCRETE MIXING. The concrete shall be mixed until there is a uniform distribution of the materials. Sufficient water shall be used in concrete in which reinforcement is to be imbedded, to produce a mixture which will flow sluggishly when worked and which, at the same time, can be conveyed from the mixer to the forms without separation of the coarse aggregate from the mortar. In no case shall the quantity of water used be sufficient to cause the collection of a surplus in the forms.

Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in Specifications for Ready-Mixed Concrete (ASTM C 94). Concrete shall be delivered and deposited in its final position within 60 minutes after adding the cement and water to the mixture.

D. DEPOSITING. Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. The concrete placing shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the corners of forms and reinforcing bars. No concrete that has partially hardened or been contaminated by foreign material shall be deposited in the work, nor shall re-tempered concrete be used.

All concrete in structures shall be compacted by means of high-frequency internal vibrators of approved type and design during the operation of placing, and shall be thoroughly worked around reinforcement and embedded fixtures and into the corners of the forms. Care must be taken not to over use vibrators causing separation of cement and aggregates.

E. FINISHING. After the concrete for slabs has been brought to the established grade and screeded, it shall be worked with a magnesium float and then given a light "broom" finish. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or hasten hardening. Surface edges of all slabs shall be rounded to a radius of 1/4 to 1/2 inch with standard concrete finishing tools.

F. CURING AND PROTECTION. As soon as the concrete has hardened sufficiently to prevent damage, the finished surface shall be kept moist for

seven days, or a chemical curing agent may be used to prevent the concrete from premature drying.

The freshly finished surface shall be protected from hot sun and drying winds until it can be sprinkled or covered as above specified. The concrete surface must not be damaged or pitted by rain. The Contractor shall provide and use, when necessary, sufficient tarpaulins to completely cover all sections that have been placed within the preceding 12 hours. The Contractor shall erect and maintain suitable barriers to protect the finished surface. Any section damaged from traffic, weather or other causes occurring prior to its official acceptance, shall be repaired or replaced by the Contractor in a manner satisfactory to the City Engineer.

G. WEATHER LIMITATIONS: No concrete shall be poured where the air temperature is lower than 35 degrees F. or from the period of November 1 to April 1 of each year unless approved by the City Engineer. When there is likelihood of freezing during the curing period, the concrete shall be protected by means of an insulating covering to prevent freezing of the concrete for a period of not less than seven days after placing or optionally to maintain the concrete temperature above 50° F for at least 3 days, with no intermittent days below 32° F. Equipment for protecting the concrete from freezing shall be available at the job site prior to placing concrete. Particular care shall be exercised to protect edges and exposed corners from freezing.

H. CONCRETE REPAIR:

1- Minor Cracking. In lieu of removing and replacing concrete with minor cracks, the City Engineer may direct the Contractor to repair the affected sections by sawing, cleaning and sealing the cracks. All cracks repaired shall be sealed with a polyurethane TTS-230 type II crack filler, or an approved silicone type crack filler Sika Flex Construction Sealant or equal approved by the City Engineer. Where modifications are to be made to existing concrete, the edges to be poured against shall be sawed and the new concrete shall be edged with a standard edging tool. Sections of curb and gutter or sidewalk shall be removed and replaced if there are more than one crack per section that is not in a joint or three or more consecutive sections with a crack that is not in a joint. A section is the area between contraction joints and/or expansion joints.

2- Minor Spalling. In lieu of removing and replacing concrete with surfaces that have minor spalling on the concrete surface , the City Engineer may direct the Contractor to repair the affected sections by use a two-component, polymer-modified, Portland cement, fast setting, non-sag mortar Sikatop 123 PLUS or equal approved by

the City Engineer. The preparation of the concrete surface and the installation of the mortar material shall the done as directed by the mortar manufacturer.

II. CONCRETE REINFORCEMENT INSTALLATION: Concrete reinforcement shall be installed as follows:

A. BENDING. Reinforcing bars shall be accurately formed to the dimensions indicated on the Plans. Bends for stirrups and ties shall be made around a pin having a diameter not less than two times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness of the bar, except that for bars larger than one inch, the pin shall be not less than eight times the minimum thickness of the bar.

B. SPLICING. Splicing of bars at points other than as shown on the Plans will be permitted only by permission of the City Engineer. Splices of reinforcement at points of maximum stress shall be avoided wherever possible, and shall be staggered when used. The minimum overlap for a lapped splice shall be 24 bar diameters, but not less than 12 inches.

C. PLACING. All reinforcing bars shall be placed accurately in the position shown on the Plans, and shall be securely held in position by annealed iron wire ties of not less than 16 gauge or suitable clips at intersection and supported by metal supports, spacers or hangers, in such a manner that there will not be any displacement while placing concrete. Reinforcing bar dowels shall either be poured or epoxied into concrete.

D. EMBEDMENT AND PROTECTION. All reinforcing steel shall be protected by concrete embedment and protective cover as shown in table 4.11, such cover in each case being the shortest distance between the face of the form or concrete surface, and the nearest edge or face of the reinforcement.

TABLE 4.11
REINFORCING BAR CLEARANCE

LOCATION OF REINFORCEMENT	COVER
Bottom bars - where concrete is deposited against ground without use of forms.	Not less than 3"
Main bars - where concrete is exposed to the weather, or exposed to the ground but placed in forms.	Not less than 2"
Bars in slabs and walls not exposed to the ground or weather.	Not less than 1"

E. FIBERMESH INSTALLATION. Fiber-mesh shall be added, according to the manufacturer's recommendations, only at the concrete batch plant to assure uniform and complete dispersion of the collated-fibrillated fiber bundles into single mono-filaments within the concrete.

III. CURB & GUTTER CONCRETE PLACEMENT. The concrete shall be placed either by an approved slip form/extrusion machine, by the formed method, or by a combination of those methods. Curb and gutter shall be placed as follows:

A. MACHINE PLACEMENT. The slip form/extrusion machine approved shall be so designed as to place, spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

B. FORMED METHOD. The forms shall be of wood, metal, or other suitable material that is straight and free from warp, having sufficient strength to resist the pressure of the concrete without displacement and sufficient tightness to prevent the leakage of mortar. Flexible or rigid forms of proper curvature may be used for curves having a radius of 100 ft. or less. Division plates shall be metal.

The front and back forms shall extend for the full depth of the concrete. All forms shall be braced and staked so that they remain in both horizontal and vertical alignment until their removal. They shall be cleaned and coated with an approved form-release agent before concrete is placed against them.
The concrete shall be deposited into the forms without segregation and then

tamped and spaded or mechanically vibrated for thorough consolidation. Front and back forms shall be removed without damage to the concrete after it has set.

C. FINISHING. The plastic concrete shall be finished smooth, if necessary, by means of a wood or magnesium float and then given a final surface texture using a light broom or burlap drag. Concrete that is adjacent to forms and formed joints shall be edged with a standard jointer or edging tool to the dimensions shown on the plans. The top, face, and flow-line of the curb and also the top of the apron on driveway aprons shall be finished true to line and grade and without any irregularities of surface noticeable to the eye.

The gutter shall not pond water when tested by water flow and no portion of the surface of the curb and gutter shall depart more than one-fourth of an inch from a straight edge, ten feet in length, placed on the curb parallel to the center line of the street, nor shall any part of the exposed surface present a wavy appearance.

D. JOINTING.

1. Contraction Joints. Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals not exceeding 10 ft. for curb and gutter, and not to exceed 5 ft. for sidewalks. Joint depth shall at least be one-eighth of the cross section of the concrete. Generally, surface areas shall not exceed 100 square feet without contraction joints, AND SPACING BETWEEN CONTRACTION JOINTS SHALL NOT EXCEED TEN FEET. Contraction joints shall be hand formed using a narrow jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete of the required depth. Other methods of installing contraction joints such as saw cutting or metal strip insertion shall be approved by the City Engineer. Saw cutting shall be done within 24-hours after the concrete has set. Steel strips shall be one eighth-inch thick and inserted into the plastic concrete temporarily and withdrawn before final finishing.

2. Expansion Joints. Expansion joints for curb, gutter and sidewalk shall be constructed at right angles to the curb line, at locations shown in the standard drawings. Spacing for sidewalk expansion joints shall not exceed 40 feet. Filler material for expansion joints shall conform to requirements of ASTM D 994, D 1751, or D 1752 and shall be furnished in a single 1/2-inch thick piece for the full depth and width of the joint.

3. Other Jointing. Construction joints may be either butt or

expansion-type joints. Curbs and gutters constructed adjacent to existing concrete shall have the same type of joints as in the existing concrete with similar spacing, however, contraction joint spacing shall not exceed 10 ft. A silicone joint sealer as defined in ASTM C 962 shall be applied to all form-plate expansion joints. The silicone joint sealer shall be applied under pressure to a depth of not less than two inches from the outside surface of the curb and gutter.

E. PROTECTION. At all times during the construction of the project, the Contractor shall have materials available at the site to protect the surface of the plastic concrete against rain. These materials shall consist of waterproof paper or plastic sheeting. For slip-form construction, materials such as wood planks or forms to protect the edges shall also be required.

F. CURING. Concrete shall be cured for at least three days after placement to protect it against loss of moisture, rapid temperature change, and mechanical injury. Moist burlap, waterproof paper, polyethylene sheeting, liquid membrane curing compound, or a combination thereof may be used as the curing material. Membrane curing shall not be permitted in frost-affected areas when the concrete will be exposed to deicing chemicals within 30 days after completion of the curing period.

G. BACKFILLING. After at least three days after placement and the forms have been removed from the concrete, the Contractor shall backfill to the line and elevation as shown on the drawings or as required by the City Engineer.

H. WEATHER LIMITATIONS: See section 4.4.2.I.G.

I. CONCRETE REPAIR: See section 4.4.2.I.H.

IV. CONCRETE BASE MATERIALS PLACEMENT: The placement of concrete base materials (pit run and road base) under curb, gutter and sidewalk shall conform to Sections 4.3.2.I and 4.3.2.II of these standards.

4.4.3. QUALITY CONTROL. All concrete and base materials shall be placed in accordance with these standards and tested as follows:

I. CONCRETE TESTING. Minimum testing of the concrete shall be as follows:

Mix Design Certification:	One per calendar year or anytime when mix design changes. Testing shall be according to the latest ASTM standards.
Compressive Strength Tests:	One set of (4) cylinders for each 50 cubic yards of concrete

placed. Test 1cylinder at 7 days, 2 cylinders at 28 days and 1 cylinder shall be held by the testing firm for a maximum of 90 days to be broke when directed by the City Engineer. Tests shall be according to ASTM C39.

Air Entrainment: One test at beginning of load placement or two consecutive passing tests if initial test fails. Others shall be taken as required. Tests shall be according to ASTM C231.

Slump Tests: One test at beginning of load placement or two consecutive passing tests if initial test fails. Others shall be taken as required. Tests shall be according to ASTM C143.

II. CONCRETE BASE MATERIAL TESTING. Minimum testing of the curb, gutter and sidewalk base materials (both pit run and road base materials) shall be tested as follows:

Gradation Tests: One test per 2000 lineal feet of curb & gutter and one test per 2000 lineal feet of sidewalk or fraction thereof.
The sieve analysis shall be according to ASTM C136, C117.

Soil Proctor: One determination of each source of base course as necessary to provide required compaction testing. Test shall be according to ASTM D1557, Method A or D (modified proctor).

Moisture Density Tests: One test per 300 lineal feet of curb & gutter and one test per 300 lineal feet of sidewalk or fraction thereof. Moisture content shall be at plus or minus 2 percent for tests to pass and shall be maintained until the concrete is poured. Tests shall be according to ASTM D1556 or D2922 and D3017.

Thickness: One random boring or test hole per 200 lineal feet of curb & gutter and one random boring or test hole per 200 lineal feet of sidewalk or fraction thereof. If sufficient inspection has been made by a City Engineer to verify required thickness, the City Engineer may waive thickness testing. No single measured thickness shall be less than the required thickness.

Testing documentation shall be according to Section 1.4 of these standards.

III ACCEPTANCE. The average of the two cylinders from the same concrete pour that are tested at 28 days shall equal or exceed the minimum specified 28-day compressive strength. If the average compressive strength of first two 28 day

cylinder breaks is below specification the hold cylinder can also be broke at 28 days. The average compressive strength of any two of the 28 days breaks from the same concrete pour must then be above the specified compressive strength. If the average 28 day compressive strength from any two cylinders from the same concrete pour is below specification, the concrete will be rejected unless approved retests prove otherwise.

Concrete with a compressive strength below the required strength shall be evaluated by the City Engineer for capabilities necessary to the integrity of the structure. The City Engineer may accept this concrete under a special guarantee from the deliverer, or require that it be replaced with acceptable material. The City Engineer shall make the final decision. If additional tests are required to determine if strength tests are representative they shall be performed by coring in accordance with ASTM C 42 method or other acceptable non-destructive methods. The re-tested strength shall be the average of three cores (or other means). All costs incurred in re-sampling and retesting shall be paid by the developer.

Any curb, gutter or sidewalk base material determined not to be in compliance with these standards shall either be removed and replaced or re-worked until compliance is obtained. Any costs for testing re-work shall be paid for by the developer.

4.5 STREET LIGHTS: This section of the Standard defines the materials to be used and the requirements for installing street lights in City streets within Cedar City.

4.5.1 MATERIALS: Street light materials in Cedar City shall conform to the following requirements:

I. LUMINARIES MATERIALS

A. Materials: The fixture base, cage and cap shall be manufactured from cast aluminum. Cast plastics or composites will not be acceptable. All hardware shall be stainless steel with tamper resistant exterior hardware.

B. Finish: The luminaries' body shall be finished with a premium quality thermoset polyester powder coat for durable finish. Color shall be as shown in Table 4.12.

C. Pole Mounting: A 3" OD Tenon slip fitter shall allow mounting to pole with (6) 5/16" stainless steel socket set screws for local and commercial luminaries.

D. Lens: Material shall be as shown in table 4.12.

E. Performance: Lighting fixture shall meet or exceed IES standards for classification of Cutoff Luminaries. Less than 2.5% of lamp lumens shall be permitted above 90 degrees from nadir, and less than 10% of lamp lumens shall be permitted between 80 degrees and 90 degrees from nadir. Maximum vertical candela shall occur between 65 and 70 degrees with an IES type III distribution minimum.

F. Reflector: Reflector assembly shall provide IES type III distribution with horizontal lamp configuration with lamp and reflector being completely concealed in top housing of fixture for local, industrial and interchange street lights. Reflector shall be manufactured from specular segmented aluminum sheet. Stamped hydro formed reflectors are not acceptable.

G. Electrical: The ballast assembly and electrical components shall be accessible from hinged assembly allowing easy access to lamp and ballast replacement. Ballast shall have voltage and wattage ratings as shown in table 4.12. Socket assembly shall be 4KV pulse rated socked. Quick disconnect clips shall be provided on all line wiring connections. A photo cell control shall be provided for each light, the photo cell shall be a twist-lock type.

H. Luminaries: Fixtures shall be provided with lamps and as shown in the standard drawings.

I. Fixture Manufacturer: The recommended manufacturers and model of fixtures shall be as shown in table 4.12 or approved equals.

J. Options: Banner arms and sign mountings shall be available for local and commercial lights. House side shields shall be available for local lights.

TABLE 4.12
STREET LIGHT FIXTURES

Light Type	Type	Material	Color	Lens	Lamps					Model #
					Type	Volts	Maximum Lumens	Lamp Supplier OAE	Fixture Supplier OAE	
Local	Pedestal	Cast Aluminum	Black	Clear Acrylic UV Protected	LED	120	3500	Philips HADCO VX 151 Or Halophane 247L	Philips HADCO Or Halophane (ARS)	VX 151 48AC 3RNA3BSN Or 247L 20LEDE70 MVOLT 4K R3 AY PCLL
Comm.	Decorative *	Cast Aluminum	Forest Green	Acrylic Refractor Globe UV Protected	LED	120	6500	Philips HADCO Lumilock GX2 LED (RL52)	Philips HADCO	Drawing # C9005 – DWGO2 cut off IES III or IV FB PCB RAL 6005
Industrial	Cobra	Cast Aluminum	Aluminum		LED	120	12,500	Halophane	Halophane	ATB2 60BLEDE70 MVOLT R4 PCLL

* Single fixture unless doubles are requested by City

II. POLE MATERIALS:

A. Pole: Pole shafts shall be constructed as shown in table 4.13 and shall be full length heat treated and wind tunnel tested for appropriate wind load. Pole shafts shall be free of longitudinal welds. Pole dimensions shall be as shown in the standard drawings.

B. Hand hole: The hand holes shall be a reinforced 2" X 4" per A87200 with lap-type cover and two stainless steel screw connections.

C. Finish: The finish shall be Premium Thermoset Powder coat finish applied to the exposed pole shaft, electro-statically applied, oven cured and bonded at approximately 400 degrees to a minimum dry film thickness of 1 1/2 mils. Color shall be as shown in table 4.13. Cold tar epoxy, properly prepared and primed shall be applied to pole areas installed below grade.

D. Cable Entry: Local street light poles shall have a 1 ½" grommeted cable entry located 18" below grade, in line with the hand hole.

E. Anti-Rotation: An anti-rotational device shall be provided on local street light poles by means of partial flattening the butt of the pole into an oval cross-section or other approved means.

F. Grounding: An internal ground lug with 3/8" hole for attaching a grounding connector shall be provided opposite the hand hole on all poles.

G. Pole Manufacturer: The recommended pole manufacturer and model of poles shall be as shown in table 4.13 or an approved equal.

TABLE 4.13
STREET LIGHT POLES

Location	Type	Material	Maximum Spacing	Color	Recommended Manufacturer O.A.E.	Model/ Drawing #
Local	Pedestal	Tapered Aluminum 0.125" Wall 6063-T6 Alloy	450 Feet	Black	Hapco Or Halophane	B88178 Or 1 800 3050 4TEA Special RFD 143538
Commercial	Decorative	Aluminum 0.250 Wall A319 & 6005-TS Alloys	450 Feet	Forest Green	Mountain States Lighting	15 EFA-Wash/L6-Cedar 5/12
Industrial	Cobra	Round Tapered Steel 7 Gauge 55 KSI	450 Feet	Galvan-ized	Valmont Or Halophane	DS30-800 E 300-8S-GV (Breakaway Base) or RTS 30 GALV 8 Mast Slip Base

4.5.2 CONSTRUCTION METHODS AND EQUIPMENT

I. ASSEMBLY: All street lights, including pole and luminaire shall be assembled according to the manufacturer's instructions before raising the assembly to its final vertical position.

II. MOUNTING: All street lights, including pole and laminar shall be raised to its final vertical position with nylon slings without damage. Once vertical, the pole shall be direct buried or mounted to base according to the manufacturer's instructions and standard drawings. The final position of the street light shall have the pole in a plumb position with the luminaire lens facing the street being

parallel to the curb. All photo cells shall face north.

III. ELECTRICAL CONNECTIONS: All electrical connections for street lights shall be accessible after the street light is in its final position with the connections conforming to the International Electrical Code.

IV. LOCATION AND SPACING: Unless designed to be installed on both sides of street, street lights should, when practical, be installed on the same side of the street and as close as possible to lot lines and street intersections while optimizing spacing and considering location of power source. The maximum spacing for streetlights shall be as shown in table 4.13. Unless otherwise approved, the base of the streetlight shall be at the back of sidewalk.

4.6 FENCES

Fences are required by City Ordinance to be constructed in certan areas, i.e. Planned Unit Developments (PUD's); Industrial Developments next to Residential Developments and denser Residential Developments next to less dense developments.

4.6.1 ALLOWED FENCE TYPES

The type of fences allowed to be installed around the developments listed in 4.6 above are as follows:

I. Masonry Block Walls- as shown on Standard Drawing F-1;
II. "Privacy Link" fence installed per Privacy Link's recommendations; or
III. "Fiberon" Fence installed per Fiberon's recommendations;

STANDARD

DETAILS