PUBLIC IMPROVEMENTS
DESIGN MANUAL AND
CONSTRUCTION SPECIFICATION
CITY OF FORSYTH, MISSOURI

Approved by the Board of Alderman on 8-19, 2003

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SECTION I
OVERVIEW

This manual is a supplement to the ordinances of the City of Forsyth, Missouri, and sets forth the requirements and policies for the design and construction of city infrastructure. The basic design parameters and specifics of approval by the city are set forth herein.

City Infrastructure shall be designed and constructed in accordance with the Missouri Department of Highway and Transportation Commission Project Design Manual and the Missouri Department of Highway Standard Specifications, the Missouri Department of Natural Resources regulations, the BOCA National Building Code, the National Electric Code, the International Plumbing Code, the International Mechanical Code, and additional standards, policies and ordinances referenced herein in the general city codes, ordinances, and policies. In general, the policies and ordinances stated herein are supplemental to the applicable State, County or Federal regulations to meet specific conditions in the City of Forsyth.

The requirements for water system permits, sewer systems permits, **excavation permits**, and road-cut permits are contained herein.

The public is encouraged to call or come to the City Hall to see the city Building Official or City Engineer for clarification of design, construction, and permitting issues.

The primary goal of these guidelines is to assure the public safety and provide for a high quality environment for those living or visiting our city.

Each development phase contractor shall provide a Performance Bond on the attached form to guarantee completion of the project work and to provide a guarantee that the completed work shall be free of defects in materials and workmanship for a period of one (1) year from the date of acceptance. The bond amount shall equal the documented cost of the construction work.

Each construction contractor shall provide a Certificate of Insurance to the City indicating coverage of claims under Workman's Compensation (legal required limit), Commercial General Liability and Property Damage Insurance with limits not less than $1,000,000 for bodily injury and death for any one person and not less than $1,000,000 aggregate sustained by two or more persons in any one accident, and $500,000 for all property damages sustained by any one person and not less than $500,000 aggregate sustained by two or more persons in any one accident. Automobile Liability Insurance for any auto shall be provided with a combined single limit of $500,000 for each accident.

Where work must be performed on private property and no easements are available, a new permanent easement shall be obtained with the City named the Grantee. The attached easement form, or similar document acceptable to the City, shall be used and after proper signatures, recorded at the Taney County Recorder of Deeds and the City provided a copy. A title search shall have been done to verify the Grantor and any lien holder with a copy provided the City. Any lien holder shall also provide a signed easement.

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS: That

_____
(Name of Contractor)

_____
(Address of Contractor)

a_____hereinafter called Principal, and
(Corporation, Partnership or Individual)

_____
(Name of Surety)

_____
(Address of Surety)

hereinafter called Surety, are held and firmly bound unto_____

City of Forsyth, Missouri
(Name of Owner)

City Hall, P.O. Box 545, Forsyth, Missouri 65653
(Address of Owner)

hereinafter called Owner, in the penal sum of_____

_____ dollars ($_____)

in lawful money of the United States, for the payment of which sum well and truly be made, we bind ourselves, successors, and assigns, jointly and severally, firmly by these presents.

The condition of this obligation is such that whereas, the Principal entered into a certain contract with _____, dated the ____ day of _____,20__, a copy of which is hereto attached and made a part hereof for the construction of:

_____

_____

_____

NOW, THEREFORE, if the Principal shall well, truly and faithfully perform its duties, all the undertakings, covenants, terms, conditions, and agreements of said contract during the original term thereof, and any extensions thereof which may be granted by the owner, with or without notice to the Surety and during the one year guaranty period, and if he shall satisfy all claims and demands incurred under such contract, and shall fully indemnify and save harmless the Owner from all costs and damages which it may suffer by reason of failure to do so, and shall reimburse and repay the Owner all outlay and expense which the Owner may incur in making good any default, then this obligation shall be void; otherwise to remain in full force and effect.

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PROVIDED, FURTHER, that the said surety for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to Work to be performed thereunder or the Specifications accompanying the same shall in any wise affect it's obligation of this Bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract or to the work or to the specifications.

PROVIDED, FURTHER, that no final settlement between the Owner and the Contractor shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

IN WITNESS WHEREOF, this instrument is executed in four (4) counterparts, each one of which shall be deemed an original, this the _____ day of _____, 20___.

ATTEST:

_____ (s)
(Principal) Secretary

_____
Principal (Please Type)

By:_____ (s)

Name_____
(Please Type)

(SEAL)

_____
(Address)

_____ (s)
Witness as to Principal

_____
(Address)

_____
(Address)

_____

ATTEST:

_____
Surety

By:_____ (s)
Attorney-in-fact

Name_____
(Please Type)

(SEAL)

_____
(Address)

_____ (s)
Witness as to Surety

_____
(Address)

_____

NOTE: Date of Bond must not be prior to date of contract. If contractor is partnership, all partners should execute bond.

IMPORTANT: Surety companies executing bonds must appear on the Treasury Department most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.
(s) Signature Required.

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RIGHT-OF-WAY EASEMENT

KNOW ALL MEN BY THESE PRESENTS: Tract No. _____

That in consideration of One Dollar ($1.00) and other good and valuable considerations paid to _____ hereinafter collectively referred to, whether one or more, as "GRANTOR", by the City of Forsyth, Missouri, hereinafter referred to as GRANTEE, the receipt of which is hereby acknowledged, the GRANTOR does hereby grant, bargain, sell, transfer, and convey unto the GRANTEE, its successor and assigns, a perpetual easement with the right to erect, construct, install and lay, and thereafter use, operate, inspect, repair, maintain, replace, and remove pipe, laterals, service pipe, and such appliances as are deemed by the GRANTEE as necessary in connection therewith over, across and through the land of the GRANTOR situated in the Taney County, State of Missouri, said land being described as follows:

together with the right of ingress and egress over the adjacent lands of the GRANTOR, his successors and assigns, for the purposes of this easement.

The perpetual easement shall be 20 feet in width, the center line thereof to be located along said pipe as installed.

Also 30 feet of temporary construction easement being a 15 foot wide strip of land adjacent to each side of the above described permanent easement. Said temporary easement shall terminate upon completion of construction.

The consideration hereinabove recited shall constitute payment in full for any damages to the land of the GRANTOR, his successors and assigns, by reason of the installation, operation and maintenance of the structures or improvements referred to herein. The GRANTEE covenants to maintain the easement in good repair so that no unreasonable damage will result from its use to the adjacent land of the GRANTOR, his successors and assigns.

The grant and other provisions of this easement shall constitute a covenant running with the land for the benefit of the GRANTEE, its successors and assigns.

IN WITNESS WHEREOF, the GRANTORS have executed this instrument this _____ day of _____, 20__.

_____(SEAL) _____(SEAL)

_____(SEAL) _____(SEAL)

INDIVIDUAL ACKNOWLEDGMENT

State of _____)
)ss.
County of _____)

On this ___ day of _____, 20__, before me a Notary Public in and for the County of _____ in the State of _____personally appeared _____ to me known to be the person(s) described in and who executed the foregoing instrument and acknowledged that (they) (he) (she) executed the same as (their) (his) (her) free act and deed.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal, at my office in _____ the day and year first above written.

My Commission expires _____

_____
Notary Public

SECTION II
WATER SYSTEM DESIGN

ARTICLE I

Unless the context specifically indicates otherwise, the meaning of terms used in this Resolution shall be as follows:

Sec. 1 "Building Service" shall mean the piping form the water meter to the customer's building plumbing.

Sec. 2 "Building Plumbing" shall mean the piping which distributes potable water throughout the structure.

Sec. 3 "City" shall mean the City of Forsyth, Missouri

Sec. 4 "Contractor" shall mean any individual, firm, partnership, or corporation hired to install water mains.

Sec. 5 "Customer" shall mean any individual, firm, partnership, corporation, political corporation or subdivision of either the state or federal government, to whom water services are made available from the owner's facilities.

Sec. 6 "Engineer" shall mean an individual registered as a professional engineer in the State of Missouri.

Sec. 7 "Missouri Department of Natural Resources" (Mo. D.N.R.) shall mean the state agency having jurisdiction over community water systems, including regulations issued by the Agency.

Sec. 8 "Potable Water" shall mean water which has been determined to meet all Missouri Department of Natural Resources regulations for human consumption.

Sec. 9 "Public Water System" shall mean a system for the provision of the public of piped water for human consumption, owned and operated by the City.

Sec. 10 "Shall" is mandatory, "should" or "may" is permissive.

Sec. 11 "Superintendent" shall mean the authorized representative of the City, whose responsibility is the operation and maintenance of the public water system.

Sec. 12 "Water Service Mains" shall mean that portion of the public water system which transmits potable water from the water source to the customers for building service and fire protection.

ARTICLE II

Sec. 1 That the specification for the construction and maintenance of water service mains of the water system of the City shall be as set forth in Section VII to this manual which is incorporated herein fully by reference thereto as if set forth herein verbatim.

Sec. 2 That water service mains of the City will be so constructed as to fully comply with the terms, conditions and specifications of said Section VII.

Sec. 3 That water service mains shall be designed by an engineer and submitted for approval to the City and the Mo. D.N.R. The design engineer shall certify the water service mains were constructed and tested in accordance with the approved plans and Section VII. The design engineer shall submit the required Mo. D.N.R. certification upon completion of the installation

Sec. 4 The design Engineer shall provide two copies of "As Built" plans which reflect the water facilities installed locations and details. An electronic copy of the plans shall be provided on a CD.

Sec. 5 That following approval by the Superintendent and certification by the engineer, the City will accept the water mains for ownership, operation, and maintenance.

ARTICLE III

Sec. 1 The customer within the City limits who requests water service which requires extension of the water service mains of the City shall request and may be granted the right to make such extension by the City. A building service line shall not cross another property other than a public right-of-way for connection to the water main of the City. A building service line shall not in the future be converted to a water service main of the City.

Sec. 2 The customer shall obtain the services of an engineer, who shall prepare design plans for the required extensions including required main extensions to connect to an existing 6" or larger main with capacity to serve the development. The plans shall be submitted to the City and Mo. D.N.R. for approval prior to beginning any work. The City's Engineer will review the plans and specifications and provide written comments to the City, including required main sizing above the minimum to fit the City Master Plan. The customer shall reimburse the City for all Engineering review cost. A copy of the Mo. D.N.R. construction permit shall be provided to the City prior to beginning any water main construction work.

Sec. 3 The customer shall obtain the services of a contractor who shall install the lines, etc., in accordance with the approved plans and specifications. The contractor shall give the City at least 48 hours Notice of intent to commence before work is begun. The Contractor shall provide a Performance Bond in the City's name to assure completion of the work and a one year guarantee on the work installed from the date of City acceptance of the work.

Sec. 4 The engineer shall prepare the plans in accordance with the following minimum conditions.

a. Design Standard or Guide for Community Public Water Supplies issued by the Missouri Department of Natural Resources, Public Drinking Water Program, latest edition.

b. Minimum main size shall be 6" in residential areas and 8" in commercial areas and shall extend to the last building lot to the customer's property line. The City's Engineering review with respect to the City's Master Plan may require the main size to be increased.

c. Main line valves shall be spaced at 500 ft. intervals in commercial districts and one block or 800 feet intervals in other districts.

d. Hydrants should be spaced at a maximum of 300 ft. intervals in commercial districts and 600 ft. intervals in other districts.

e. Mains shall be looped where feasible, as determined by the City.

f. Dead end mains shall have a fire hydrant placed at the end.

g. The water main design should include delivery of 2500 gpm for commercial districts and 1000 gpm for all other districts, for fire protection, with 20 psi minimum pressure at any location within the distribution system.

h. Maximum static pressure shall be 100 psi. Service to areas with higher pressure shall be protected by a pressure reducing station containing a 2" and a 4" pressure reducing valve minimum size. The station shall be constructed of a 5 feet diameter precast concrete section with flat top. A 30" x 36" open aluminum hatch to be provided. A main line bypass valve shall be provided plus two isolation valves for each reducing valve, and a pit drain are required. At the lowest point of the system protected by a pressure reducing station, a 2" minimum pressure relief valve shall be installed on a 2" minimum lead with gate valve off the main. The relief valve shall be installed in a 24" meter pit and have a 2" minimum external relief pipe terminating above grade with a screened 180°F fitting using galvanized piping.

i. The design shall include building service connections including saddle and corporation stop at the main, and sufficient service line to the meter location at the customer's property line where the meters are to be located on the opposite side of the street from the main tap.

j. Any building plumbing serving a business or a multi-family resident shall be installed so that water serving each separate office, business of living space may be metered and billed separately, or with approval of the City, a single master meter may be installed.

k. The design shall include a review of the City's ability to provide the projected peak flows during the peak day usage from the past 3 years of City experience.

Sec. 5 The customer shall be responsible for all cost of engineering, construction and any associated cost resulting from the extension of the water service mains.

Sec. 6 The City will provide written approval for the extension. The City reserves the right to not approve any extension. The City reserves the right to require a main larger than 6" be installed. If the City exercises this option, the City will pay the difference in the cost of pipe, valves and fittings between the size to be installed and the minimum 6".

Sec. 7 The City will review its ability to provide the water demanded by the extension. The City may require the customer to help defray any cost the City incurs to their water sources or storage to approve the customer's extension request.

Sec. 8 The customer shall be responsible for acquiring any easements for main extensions where private property must be crossed. The easement shall be approved by the City and the grantee shall be the City of Forsyth, Missouri. The customer shall obtain a title search to confirm the grantor and record the easement at the Taney County Recorder of Deeds and Provide the City with a copy of the recorded document.

Sec. 9 The customer shall acquire the approval of the City of Forsyth, the Taney County Highway Department or the Missouri Department of Transportation where any main extension uses their respective right of ways. A copy of the approval or permits shall be provided to the City.

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SECTION III
SANITARY SEWER SYSTEM DESIGN

ARTICLE I

Unless the context specifically indicates otherwise, the meaning of terms used in this Ordinance shall be as follows:

Sec. 1 "Building Drain" shall mean that part of the lowest horizontal piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer, beginning five (5) feet, 1.5 meters outside the inner face of the building wall.

Sec. 2 "Building Sewer" shall mean the extension from the building drain to the public sewer or other place of disposal.

Sec. 3 "City" shall mean the City of Forsyth, Missouri.

Sec. 4 "Contractor" shall mean any individual, firm, partnership, or corporation hired to install sewer mains.

Sec. 5 "Customer" shall mean any individual, firm, partnership, corporation, political corporation or subdivision of either the state or federal government, to whom sewer services are made available from the City's facilities.

Sec. 6 "Engineer" shall mean an individual registered as a professional engineer in the State of Missouri.

Sec. 7 "Missouri Department of Natural Resources" (Mo. D.N.R.) Shall mean the state agency having jurisdiction over community sewer systems, including regulations issued by the Agency.

Sec. 8 "Public Sewer" shall mean a sewer in which all owners of abutting properties have equal rights, and is controlled by public authority.

Sec. 9 "Sanitary Sewer" shall mean a sewer which carries sewage and to which storm, surface and groundwaters are not intentionally admitted.

Sec. 10 "Sewage" shall mean a combination of the water carried wastes from residences, business buildings, institutes, and industrial establishments, together with such ground, surface and stormwaters as may be present.

Sec. 11 "Sewage Treatment Plant" shall mean any arrangement of devices and structures used for treating sewage.

Sec. 12 "Sewage Works" shall mean all facilities for collection, pumping, treating and disposing of sewage.

Sec. 13 "Sewer" shall mean a pipe or conduit for carrying sewage.

Sec. 14 "Shall" is mandatory, "should" or "may" is permissive.

Sec. 15 "Superintendent" shall mean the authorized representative of the City, whose responsibility is the operation and maintenance of the public sewer system.

ARTICLE II

Sec. 1 That the specification for the construction of sewer lines, pumping stations auxiliary power generator, and force mains of the sewer works of the City shall be as set forth in Section VIII, IX, X, XI, XII, and XIII to this manual which is incorporated herein fully by reference thereto as if set forth herein verbatim.

Sec. 2 That sewer lines of the City will be so constructed as to fully comply with the terms, conditions and specifications.

Sec. 3 That sewer lines shall be designed by an engineer and submitted for approval to the City and the Mo. D.N.R. The design engineer shall certify the sewer lines were constructed and tested in accordance with the approved plans and specifications.

Sec. 4 The Design Engineer shall provide two copies of "As Built" plans which reflect the sewer facilities installed locations and details. An electronic copy of the plans shall be provided on a CD.

Sec. 5 That following approval by the Superintendent and certification by the engineer, the City will accept the sewer lines for operation and maintenance.

ARTICLE III

Sec. 1 The customer who requests sanitary sewer service which requires extension of the sewer lines of the City shall request and may be granted the right to make such extension by the City. A building sewer shall not cross through or past another property other than a public right-of-way for connection to sewer.

Sec. 2 The customer shall obtain the services of an engineer, who shall prepare design plans for the required extensions including required sewer extension required for connection to the city sewer by gravity, pumping station, force main or combinations thereof. The plans shall be submitted to the City and Mo. D.N.R. for approval prior to beginning any work. The City's Engineer will review the plans and specifications and provide written comments to the city and customer. The customer shall reimburse the City for all Engineering Review Cost. A copy of MoDNR construction permit shall be provided to the City prior to beginning work.

Sec. 3 The customer shall obtain the services of a contractor who shall install the sewage works in accordance with the approved plans and specifications. The contractor shall give the City at 48 hours notice of intent to commence work. The contractor shall provide a Performance Bond in the City's name to assure completion of the work and a one-year guarantee on the work installed from the date of city acceptance of the work.

Sec. 4 The engineer shall prepare the plans in accordance with the following minimum conditions.

a. Minimum line size shall be 8". Sewage flows shall assume a minimum of three persons per home and 100 gal. per persons per day.

b. The design shall conform to the Missouri Dept. of Natural Resources rules published as "Division 20, Chapter 8, "Design of Sewage Works", latest edition.

c. Gravity flow sewers shall be designed and connected to the existing City sewers. Where existing City sewers are not available for connection by gravity flows, a sewage pumping station and force main shall be installed. The required sewage works shall meet all the requirements of the Missouri Department of Natural Resources and the City Superintendent. Sewer flow line depth shall not exceed 8 feet unless approved by the City.

d. The design shall include building sewer connection, tee or wye, and sufficient service line a point within 10 feet of the property to be served and capped. Each end of service line shall be accurately recorded and provided to the City in the form of "As Built" plans.

e. The design shall include a review of the City's ability to provide treatment of the projected organic and hydraulic loading to be discharged from the extension.

f. The plans shall include a plan view at a scale of 1"=50' or larger. The plan shall include a profile view at a scale of 1"-50' or larger for all gravity and pressure mains. Elevations shall be based on the USGS datum. Plans with plan views and elevations shall be provided for pumping stations and wet wells. An electrical service detail and wiring diagram shall be provided.

g. Sewage pump station design shall include capacities for adjacent upstream developments. The station alarm shall include a 120 volt light and horn and a separate 12 V.D.C. alarm light and horn for power failure. The design should attempt to provide sewage flow storage of at least 2 hours at the peak estimated flow rate using a combination of mains, manholes, wet well, and storage tank or basin without overflows or building backups.. If a tank or basin is to be used, the tank shall be enclosed reinforced concrete and the basin shall have a concrete lining. Where storage is not a viable alternative, a standby generator with auto-transfer switch shall be provided, including specifications for approval by the City.

h. Pressure collection and grinder pump stations are not to be used unless specific approval is obtained from the City. Where grinder pumps are used, a spare pump shall be provided for the first 10 units installed, plus one additional spare for each multiple of 10 units.

Sec. 5 The customer shall be responsible for all cost of engineering, construction and any associated cost resulting from the extension of the sewage works.

Sec. 6 The City will provide written approval for the extension. The City reserves the right to not approve any extension. The City reserves the right to require a main larger than 8" be installed. If the City exercises this option, the City will pay the difference in the material cost of pipe and fittings, of the larger pipe and fittings. The City reserves the right to have the pump station enlarged with the City paying the difference in the cost of the equipment for the enlarged installation. The City reserves the right to increase the force main size with the City paying for the difference in cost of the pipe materials and fittings of the larger force main.

Sec. 7 The City will review its ability to receive, transmit and provide treatment of the wastewater to be discharged by the extension. The City may require the customer to help defray any cost the City incurs to their sewage works to approve the customer's extension request.

Sec. 8 The customer shall be responsible for acquiring any easements for main extensions where private property must be crossed. The easement shall be approved by the City and the grantee shall be the City. The customer shall obtain a title search to confirm the grantor and record the easement at the Taney County Recorder of Deeds and Provide the City with a copy of the recorded document.

Sec. 9 The customer shall acquire the approval of the City, the Taney County Highway Department or the Missouri Department of Transportation where any main extension uses their respective right of ways. A copy of the approval or permits shall be provided to the City.

SECTION IV
STREETS, PARKING, AND STORM DRAIN DESIGN

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SECTION IV
STREETS, PARKING, AND STORM DRAIN DESIGN

ARTICLE I
DEFINITIONS

Unless the context specifically indicates otherwise, the meaning of terms used in this Ordinance shall be as follows:

Sec. 1 "Alley" A minor way which is used primarily for vehicular service access to the back or the side of properties otherwise abutting street.

Sec. 2 "Arterial Street (Primary)" A street or highway primarily intended to provide for high volume, moderate speed, and extended trip length traffic movement between major activity centers, with access to abutting property subordinate to major traffic movement.

Sec. 3 "Arterial Street (Secondary)" A street which interconnects with a augments the major arterial system. The secondary arterial is primarily intended to provide for moderate volume, moderate speed, and short to moderate trip length while providing partially controlled access to abutting property.

Sec. 4 "Bench Mark" A permanent object of known elevation and location that is in an area where disturbance is unlikely.

Sec. 5 "Block" A piece of parcel of land entirely surrounded by public highways, street, streams, railroad right-of-way, parks, or a combination thereof.

Sec. 6 "Bridge" A structure having a clear span greater than twenty (20) feet or a multiple span structure where the total length of the span is in excess of twenty (20) feet.

Sec. 7 "City" shall mean the City of Forsyth, Missouri.

Sec. 8 "Collector Street" A street which collects and distributes traffic to and from local and arterial streets systems. The collector is primarily intended to provide for low to moderate volume, low speed, and short length trips while providing access to abutting property.

Sec. 9 "Contractor" shall mean any individual, firm, partnership, or corporation hired to install in streets and storm drains.

Sec. 10 "Corner" A point of intersection of lines of two street curb faces extended into street intersection.

Sec. 11 "Crosswalk" A right-of-way, dedicated to or set aside for public use, which cuts across a block or street to facilitate pedestrian access to adjacent streets and properties.

Sec. 12 "Cul-de-sac or Dead-end Street" A minor land access street with only one outlet.

Sec. 13 "Culvert" A structure not classified as a bridge, which provides a conduit for drainage.

Sec. 14 "Curb Return" A portion of curb at the beginning of a driveway approach, which serves as a transition from the height of the curb to the level of the approach.

Sec. 15 "Driveway" An area intended for the operation of automobiles and other vehicles from the street right-of-way lines to a garage, parking area, building entrance, structure, or approved use location on the property. any dimensions relating to the width of a driveway or driveway surface shall be measured at the right-of-way line.

Sec. 16 "Driveway Approach" An area intended for the operation of automobiles and other vehicles giving access between a roadway and abutting property. The driveway approach includes the sum of the curb returns on each side of the driving surface, plus the driving surface.

Sec. 17 "Easement" A grant by the property owner to the public, a corporation, or persons of the use of land for specific purposes.

Sec. 18 "Engineer" shall mean an individual registered as a professional engineer in the State of Missouri.

Sec. 19 "Expressway" A street or highway with limited and partially controlled points of access at arterial system intersections. The expressway is primarily intended to provide for high volume, moderate to high speed extended intra-city traffic between major activity centers with minimal impairment to movement.

Sec. 20 "Freeway" A divided highway with fully controlled access limited to grade-separated interchanges constructed at major thoroughfares. A freeway is primarily intended to provide for high-volume, high-speed intercity traffic movements.

Sec. 21 "Gutter" That portion of the driving surfaces of an improved street, driveway, approach, or other public way, which abuts the curb and provides for the runoff of surface drainage.

Sec. 22 "Improved Street" A public street having concrete curbs, or curb and gutters, or other such equivalent physical features, which serve to establish a permanent street grade.

Sec. 23 "Intersection" The general area where two or more roadways meet, join, or cross at a common point establishing an area within which vehicles traveling different roadways may come in conflict.

Sec. 24 "Joint Driveway" A driveway which provides access to a public street for more than one parcel of land.

Sec. 25 "Local Street" A street primarily providing direct access to abutting property and design to accommodate low-volume, low-speed traffic.

Sec. 26 "Lot" A undivided tract or parcel of land under one ownership having access to a street, whether occupied or to be occupied by a building or building group together with accessory buildings, which parcel of land is designated as a separate and distinct tract, and is identified by a tract or lot number or symbol in a duly approved subdivision plat filed of record.

Sec. 27 "Missouri Department of Natural Resources" (MoDNR.) shall mean the state agency having jurisdiction over community Land Disturbance Permits, including regulations issued by the Agency.

Sec. 28 "Owner" Any individual, firm, association, syndicate, partnership, corporation, trust, or any other legal entity having sufficient proprietary interest in the land sought to be subdivided to commerce and maintain proceedings to subdivide the same.

Sec. 29 "Parkway" That portion of the street right-of-way between the edges of the roadway and the adjacent property line, or lines, on the same side of the street except any portion used for sidewalks.

Sec. 30 "Preliminary Plat" The preliminary map, drawing, or chart indicating the proposed layout of the subdivision initially required in the subdivision process.

? PLAT

Sec. 31 "Property Description" Description of a lot, tract, or parcel of metes and bounds, by reference to a plat or by reference to government survey.

Sec. 32 "Property Line" The boundary between two or more parcels of land.

Sec. 33 "Public Improvements" Those things that are constructed, installed, or performed on public land, or on land that is to become public in the subdivision process, including but not limited to street and alley pavement, curbs, storm drainage facilities, sidewalks, and sanitary sewers, and including the grading of such land.

Sec. 34 "Reference Points" Points of reference located by a survey of the project. The points are to be tied or referenced to at least three identifiable features.

Sec. 35 "Right-of-Way" A general term denoting public ownership or interest inland, usually in a strip, which has been acquired for or devoted to the use of a street or alley.

Sec. 36 "Right-of-Way Line or Street Right-of-Way Line" The boundary between any public street or alley and one or more parcels of private property.

Sec. 37 "Roadway" That area of a street intended and used for vehicular travel.

Sec. 38 "Service Road" A minor street which is parallel and adjacent to an arterial street and which provides access to abutting properties and protection from through traffic.

Sec. 39 "Shall" is mandatory, "should" or "may" is permissive.

Sec. 40 "Sidewalk" That paved portion of a parkway intended for the use of pedestrians.

Sec. 41 "Sight Distance Triangle" A triangular-shaped area of street right-of-way, generally acquired at major intersections to ensure adequate sigh distance.

Sec. 42 "Storm Water Detention Facility" A drainage facility designed and constructed for the purpose of detaining the peak rate of storm water runoff from a specified rainstorm.

Sec. 43 "Streets" "Streets" is a way for vehicular traffic, whether designated as a street, highway, thoroughfare, parkway, throughway, road, avenue, boulevard, lane, place, or however otherwise designated.

Sec. 44 "Subdivision" The division of land into tow (2) or more lots, tracts, or parcels for the purpose of transfer of ownership or building development, or if a new street or easement of access is involved, any division of a parcel of land. The term includes resubdivision and, when appropriate to the context, shall relate to the process of subdividing or to the land subdivided.

Sec. 45 "Subgrade" The surface of a street on which a base course or riding surface is to be placed.

Sec. 46 "Superintendent" shall mean the authorized representative of the City, whose responsibility is the inspection and maintenance of the public infrastructure.

Sec. 47 "Surveying" The act of determining the positions of points of the earth's surface by means of measurement of distance, direction, and elevation.

Sec. 48 "Tendering" The legal transfer of ownership and maintenance responsibility of a public improvement to the City.

Sec. 49 "Unimproved Street" A street not having concrete curbs, or curbs and gutters, or other such equivalent physical features which serve to establish a permanent street grade.

ARTICLE II
GENERAL

Sec. 1 That the specification for the construction of streets, parking, sidewalks, curbs, storm drain lines and appurtenances shall be as set forth in Section XIV to this manual.

Sec. 2 That streets, parking and storm drains of the City of Forsyth, Missouri, will be so constructed as to fully comply with the terms, conditions and specifications.

Sec. 3 That streets, parking and storm drains shall be designed by an engineer and submitted for approval to the City and the Mo. D.N.R., as applicable for land disturbance permit, prior to beginning any work.

Sec. 4 That following approval by the Superintendent and certification by the engineer, the City will accept the street, parking and storm drains for operation and maintenance.

ARTICLE III
SERVICE REQUEST

Sec. 1 The customer who requests street and drainage improvements shall request and may be granted the right to construct such improvements by the City.

Sec. 2 The customer shall obtain the services of an engineer, who shall prepare design plans for the required improvements. The plans shall be submitted to the City and Mo. D.N.R. for approval prior to beginning any work.

Sec. 3 The customer shall obtain the services of a contractor who shall install the improvements in accordance with the approved plans and specifications.

Sec. 4 The engineer shall prepare the plans in accordance with the minimum conditions which are identified in this manual.

Sec. 5 The customer shall be responsible for all cost of engineering, construction and any associated cost resulting from the street, parking and drainage improvements.

Sec. 6 The City will provide written approval for the improvements. The City reserves the right to not approve any improvements.

ARTICLE IV
CURB AND GUTTER

Sec. 1 Curbs and gutters shall be required in all subdivisions unless the Board shall find all the following conditions to exist:

A. The average lot area in a residential subdivision is three (3) acres or in excess of three (3) acres.

B. Surface drainage can be adequately controlled with a ditched system constructed in accordance with the construction specifications for the City of Forsyth.

C. Curb and gutter may be required in order to extend the existing curb and gutter or where curb and gutter is required to control erosion.

Sec. 2 Curb and gutter shall be ~~30~~ 24" Amended 5-16-05 BJA" wide, 6" minimum thickness of Portland Cement Concrete, 6" top of curb to gutter dimension.

ARTICLE V
SUB-BASE

Sec. 1 Non-residential collector streets or streets intended for use within commercial and industrial subdivisions shall have a minimum of 4" of bituminous plant mix base over 6" of compacted Type 1, aggregate base rock (95% and over compaction).

Sec. 2 Collector streets for primarily residential traffic shall have a minimum of 2" of bituminous plant mix base over 6" of compacted Type 1, aggregate base rock (95% per and over compaction).

Sec. 3 Local streets for primarily residential traffic shall be a minimum of 6" of compacted Type 1, aggregate base rock (95% and over compaction).

Sec. 4 Arterial streets to be determined case by case.

Sec. 5 Sub-base preparation and placement must meet the Missouri Standard Specifications for Highway Construction, Division 300, Bases and Aggregate Surfaces.

ARTICLE VI
STREETS AND ROAD PAVING

Sec. 1 Roads and Streets may be constructed of Portland Cement Concrete – All concrete must meet the Missouri Standard Specifications for Highway Construction, Division 500, Rigid Pavements – Sub-base must meet 95% and over compaction. Standard mix designs for machine placed (PCC-MF) and hand finished (PCC-HF) concrete pavements shall be adhered to.

Sec. 2 All streets other than concrete shall have a minimum of 2" asphalt bearing surface course constructed over the sub-base. All bituminous asphalt mix shall meet all requirements of the Missouri Standard Specifications for Highway Construction, Division 401, Flexible Pavements, BP-2, Grade.

ARTICLE VII
STREETS

Sec. 1 New streets shall be considered in their relation to existing, platted or planned streets, to topographical conditions, public convenience and safety, and to the proposed land uses of land to be served by the proposed streets.

Sec. 2 Land access local streets shall be designed so as to discourage through traffic.

Sec. 3 Provision must be made for the extension and continuation of arterial and collector streets into and from adjoining areas.

Sec. 4 Subdivisions abutting or containing an existing or proposed arterial street, marginal access streets or reverse frontage lots, access to abutting properties will be required.

Sec. 5 The distance between the center lines of streets opening onto the opposite side of and existing or proposed street shall be not less that 150 feet.

ARTICLE VIII
CUL-DE-SACS

Sec. 1 Shall be permitted only on land access streets; shall not be longer than 800 feet and shall be provided at the closed end with a turnaround having a right-of-way width of at least 200% of the required street right-of-way width and a pavement diameter from back of curb to back of curb of at least 267% of the required pavement width but less than 100 feet right-of-way and 80 feet of paving.

ARTICLE IX
ALIGNMENTS

Sec. 1 Arterial and collector streets shall be designed so at to facilitate the flow of traffic. Minimum curve radii shall be selected and curves designed so as to facilitate the flow of traffic at anticipated vehicle speeds.

Sec. 2 All streets shall have curves designed for any change direction in excess of one degree.

ARTICLE X
SIGHT DISTANCE

Sec. 1 Proper sight distance shall be provided with respect to horizontal and vertical alignment. Measured along the center line, 4 feet above grade, 300 ft. for arterials and secondary arterials, and 200 feet for collectors, and 150 feet for local streets. Where two streets of different classification intersect, the sight distance for a higher classification shall prevail.

ARTICLE XI
GRADE AND CURVES

Sec. 1 The minimum grade on all streets shall be one-half (0.5%) percent. The maximum grade shall be 5% on primary arterials, 6% on secondary arterials, 8% on collectors and 10% on land access streets. Variation from these standards may be allowed upon engineer's review and acceptance based on site specific constraints.

Sec. 2 Horizontal curves shall conform to the following minimum criteria:

	Design Speed	Min. Centerline Radius
Local	25-30 mph	175 feet
Residential Collector	30-35 mph	300 feet
Commercial/Industrial Collector	30-35 mph	400 feet
Arterial/Secondary Arterial	35-45	600 feet

Sec. 3 Vertical curves shall be used in changes of grade exceeding 2%. The length of vertical curve shall be no less than that determined by the formula:

L = K A, where: L = length of vertical curve. A equals algebraic difference in grades, K shall be determined by the following table:

	Crest	Sag
Arterial/Secondary Arterial	80	60
Collector	40	50
Local	20	30

Sec. 4 Intersections shall be approached on all sides by leveling areas where the grade excess 7%. Such leveling areas shall have a minimum length of 75 feet measured from the intersection of the center lines within which no grade shall exceed a maximum 5%.

ARTICLE XII
MINIMUM STREET AND PAVEMENT WIDTHS

Sec. 1 Minimum right-of-way widths and width of paving and curb from back of curb to back of curb shall be as follows:

	Type of Street	Right-of-Way	Paving & Curb
Local	Residential	50 feet	29 feet
	Industrial/Commercial Local	60 feet	37 feet
Collector	Residential	50 feet	31 feet
	Industrial/Commercial	60 feet	37 feet
Arterial/Secondary Arterial		60-80+ feet	To be determined- (37-41 feet typically)

Sec. 2 Provision for additional street right-of-way width may be required by the City in specific cases for the reasons of public safety and convenience. Additional off-street parking in industrial, commercial, and residential areas may also be required by the City. The city will designate whether the streets are local, collector, secondary arterial, or arterial.

ARTICLE XIII
STREET INTERSECTIONS

Sec. 1 Intersections, involving the junction of more than two streets shall be prohibited.

Sec. 2 The angle of the intersection of the street center line shall not be less than 85 degrees when a collector or arterial street is involved, and 80 degrees for intersection of land access streets. Right angle intersection shall be used whenever practical.

Sec. 3 Street curb intersections shall be rounded by a tangential arc with a minimum radius of 15 feet where a minor residential land access street is involved, 25 feet for intersections involving two residential land access streets, 30 feet for intersections involving collector or arterial streets; except where substantial use is anticipated by large trucks and semi-trailers; curb radius shall be increased to accommodate the anticipated use.

Sec. 4 Radius corners or diagonal cutoffs shall be provided on the property lines and substantially concentric with the curb radius or parallel to the chord of the curb radius so as to maintain the parkway width.

ARTICLE XIV
OTHER REQUIREMENTS

Sec. 1 Half streets are prohibited except where required in order to complete an existing half street.

Sec. 2 Where the subdivision adjoins undeveloped land, streets shall be extended to the boundary lines of the subdivision as necessary to provide adequate access for the development of adjacent land. Temporary turnarounds shall be installed at the boundary lines or end of the proposed street by paving the full right-of-way at least 25 feet wide.

Sec. 3 Streets shall be named so as to conform to existing street names and to avoid duplication.

Sec. 4 Streets may be constructed of Portland Cement Concrete or with bituminous plant mix. Seal coat will not be accepted on any street or road in the City.

Sec. 5 In the Residential, Commercial and Industrial Districts:

A. In Residential districts Collector streets shall be constructed of 6" of base rock plus 2" of bituminous plant mix surfaced with 2" of asphalt driving surface.
B. In Residential districts local streets shall be constructed of 6" of rolled stone base surfaced with 2" of asphalt driving surface.
C. In Industrial and Commercial districts all streets shall be constructed with 6" of rolled stone base plus 4" of bituminous plant mix surfaced with a 2" asphalt driving surface.

All asphaltic materials shall meet Missouri Standard Specifications for Highway Department prior to starting any construction.

ARTICLE XV
SIDEWALKS

Sec. 1 Sidewalks shall be required on one side of the street within proposed subdivisions unless the streets fall under the following classifications, which would require sidewalks on both sides of these streets:

A. Primary or secondary arterial streets.
B. Collector streets.
C. Industrial and Commercial streets.

Sec. 2 Outside edges of sidewalks shall be placed one foot inside the street right-of-way line. Residential or commercial sidewalks have minimum width of 4 feet and must comply with the "Americans with Disabilities Act".

Sec. 3 Sidewalks shall be constructed of Portland Cement Concrete over 4" of wet compacted base rock. Sidewalks shall be 4" thick. When placing new driveways, existing sidewalk which was approved as a part of driveways, existing sidewalk which was approved as part of the subdivision improvements maybe left in place provided it has not been broken or cracked. One-half inch thick expansion material shall be provided between existing concrete and new concrete. Where new sidewalk is constructed with the driveway the sidewalk pavement shall match the required pavement thickness of the driveway, yet no less than 6".

Sec. 4 The surface of the walk shall have a cross-slope of one-quarter inch per foot toward the street. Improvement plans should show the walk in plan, profile (profile only required if walks are not adjacent to streets), and typical cross sections.

Sec. 5 Expansion joints one-half inch in thickness shall be constructed at each side of the drives, at intersecting walks or curbs or other locations as needed. If sidewalks are placed adjoining curb and gutter, transverse expansion joints should be placed wherever there are expansion joints in the curb or gutter.

Sec. 6 Wheelchair ramps are required at all street intersections and mid-block crossings. No drainage structure shall be permitted at ramps. Wheelchair ramps shall meet all ADA Standards.

ARTICLE XVI
INSTALLING POLES, PIPE OR CABLE, EXCAVATING, BORING, CUTTING ON CITY STREETS OR RIGHT-OF-WAY

Sec. 1 A minimum of $5,000.00 bond shall be required made in favor of City of Forsyth. (A larger bond may be required as determined by size and location for the work proposed.)

Sec. 2 A right-of-way work permit shall be required prior to any work being started.

Sec. 3 Plans must be submitted to and approved by the City of Forsyth prior to a permit being issued.

Sec. 4 Barricades and signs must be placed in accordance with the Missouri Standard Specifications for Highway Construction and the Manual on Uniform Traffic Control Devices.

Sec. 5 Boring:

A. When the cause for placement of cable and/or pipe to cross the roadway, such placement shall be by boring for said cable or pipe. If cable or pipe would require a size of 4" or greater, said cable or pipe shall require installation of a sleeve. In emergencies, cut or excavation in the driving surface may be allowed by the City approval in writing.

B. When work is of such a nature as to necessitate the cutting of a roadway surface, such cut area shall be restored with State approved high early strength concrete of a minimum of 8" thick with a minimum of 2" of bituminous mix cap meeting Missouri Specifications for Highway Construction. (Alternate: 12" of bituminous black base may be substituted for the 8" of concrete. This must be placed in 3" lifts and compacted with an approved mechanical tamper or roller. This "Alternate" must first be approved in writing by the City.)

C. It shall be the responsibility of parties performing the boring or cutting of a road to contact the City, 24 hours before any work is started or any repairs are made. Work or repairs done without contacting the City may result in the rejection of any or all work or repairs being done.

D. Prior to any excavations required to retrieve lodged or entangled pneumatic boring equipment, approval must be obtained from the City.

E. Setback for boring pit has to be specified.

F. Exposed casement shall be epoxy coated.

G. Minimum cover for casing shall be 36".

H. Ends of casings shall extend to a minimum of 3 ft. behind a curb, a storm sewer pipe, or a water main.

Sec. 6 Backfill:

A. Any cuts or excavations within 2 feet of the driving surface shall be backfilled with wet crushed limestone base a minimum of 12" deep in compacted lifts of no more the 6". Each lift shall be tamped thoroughly with a mechanical tamper before succeeding layers are placed. These cuts or excavations must be repaired within 15 days; no exceptions.

B. The contractor shall have the option of backfilling to the surface within the right-of-way with clean crushed rock or paying the cost of compaction tests as deemed necessary by the City. Backfill and bedding material shall be crushed stone or crushed gravel conforming to the requirements of ASTM Standard C33, and having a gradation as follows:

	Percent by Weight
Passing 5/8" sieve	100
Passing 1/8" sieve	75-100
Passing 3/8" sieve	30-75
Passing #4 sieve	5-25
Passing #8 sieve	0-6

C. If the rock backfill is used, a ditch check will be required at a minimum of every 300 feet. The City may require flowable concrete backfill.

Sec. 7 Cuts or excavations within the driving surface, if determined to be necessary by the City, shall be repaired as per Standard Details attachment. Concrete and asphalt must meet the Missouri Standard Specifications for Highway Construction. These cuts or excavations must be temporarily repaired within 24 hour period; no exceptions.

Sec. 8 All installations of poles and wires must be set as close to property line as possible, no more than one foot away. Lines and pipe must be within a 4 feet corridor along the property line and never in the ditch line or any closer to the driving surface than 4 feet.

Sec. 9 It shall be the responsibility of parties performing such road and/or right-of-way work to contact the City for the necessary inspections and on completion of work.

Sec. 10 A deviation from these regulations will be on a case by case basis. Approval must be obtained from the City prior to any changes being made. Any deviation shall need approval in writing.

ARTICLE XVII
DRIVEWAYS

Sec. 1 Type 1 Driveway shall be a residential/field entrance 15' - 40' wide, measured at the right-of-way line. Driveways ideally shall have a minimum 10' side set back from property line. Residential private driveways shall be constructed of asphalt pavement or concrete pavement to the right-of-way line. Crushed rock or gravel may extend into private properties.

Asphalt drives shall be constructed within the right-of-way of 4" of wet compacted base rock, 4" of bituminous base mix, and 2" of asphalt surface course. Concrete driveways shall be constructed of plain Portland Cement Concrete 6" thick over 4" of wet compacted base rock.

Sec. 2 Type 2 Driveway shall be Commercial/Industrial entrance 24' - 60' wide, measured at the right-of-way line. Driveway shall have a minimum radius of 10 feet. Commercial/Industrial driveways shall be constructed within the right-of-way of 4" of wet compacted base rock, 8" of bituminous base mix, and 2" of hot mix surfaces course; or plain Portland Cement Concrete 8" thick over 4" of wet compacted base rock.

Sec. 3 Driveways shall not be steeper than 4% within the right-of-way. – ? needs changed

Sec. 4 Minimum sight distance on driveways shall be measured 12 feet from edge of payment as follows:

375' @ 50 mph
325' @ 45 mph
275' @ 40 mph
225' @ 35 mph
200' @ 30 mph

Sec. 5 All entrances into City streets shall be designed and constructed to accommodate storm drainage runoff. Inlets and piping shall be utilized to intercept flows prior to entry into the curb and gutter line of the street where possible.

ARTICLE XVIII
RESIDENTIAL PARKING AND COMMERCIAL PARKING AREAS

Sec. 1 Residential Parking:

A. Each residential property owner shall provide sufficient off street parking for his or her individual needs. Parking on the city street will not be permitted.

Sec. 2 **Public Parking Areas:**

A. All public facilities (except those in areas zoned as industrial) shall provide adequate parking to serve the public and employees. In addition, all commercial and public parking shall meet the following requirements:

1. All commercial, industrial, and/or public parking areas shall be asphalt or concrete paved.
2. The minimum structural section for asphalt paved parking areas shall be 2" of BP-2 grade pavement on a minimum of 6" of Type 1 Base.
3. The minimum structural section for concrete paved parking areas shall be 6" of Portland Cement Concrete pavement on 4" of Type 1 Base.
4. ADA handicapped parking shall be in accordance with:

a. City of Forsyth Building Code
b. Handicapped access ramps shall be provided as necessary.

B. The parking areas shall be drained to suitably designed storm drainage systems. Flows should be intercepted prior to entry into the street gutter. Refer to the storm drainage requirements.

1. Minimum cross-slopes for drainage shall be 0.5% for one axis and 1.0% for the transverse axis.
2. The minimum radius for edge of pavement at entrances and exit shall be 15 feet.
3. The minimum width of entranceway for one-way entrances shall be 12 feet, and for two-way entrances shall be 24 feet.

ARTICLE XIX
TRANSFERRING PRIVATE STREETS TO THE CITY

The guidelines for consideration in accepting existing private roads into the public road system are:

Sec. 1 Ninety-five percent of the residents living on the street to be transferred to the city must request the transfer to the city.

Sec. 2 The certified plat and written ROW or easement transfer documents must accompany the request. The easement or ROW shall provide the maximum width attainable, not to exceed 50 for residential streets, 60 feet for collector streets, and wider as necessary for arterial streets.

Sec. 3 The private roadway must lie wholly within the city limits.

Sec. 4 The private road must serve not less than one residence or commercial facility for each 1/8th mile of roadway and shall serve not less the four residences or commercial enterprises on the street.

Sec. 5 The street owners shall grant or transfer ROW or easements as approved by the Board of Alderman. Such ROW or easement should conform as closely as practicable to the standards for new construction shown in City Design Manual for Roadways, Streets, and Parking and shall be recommended by the City Engineer.

Sec. 6 The basic intent of this policy is that existing streets will be transferred into the city inventory on an as is basis subject to the following:

A. The roadway or street shall be asphalt or concrete paved.
B. The roadway shall be in good repair, free of potholes and failed subgrade.
C. Drainage structures shall be provided as necessary and shall be in good repair.

Sec. 7 The specific intent of the amendment is to allow the city to accept existing streets that are in good repair into the public street inventory even though they may not conform to the standards for new construction. These streets would then be maintained in an "as is" condition unless specific safety or other concerns would require significant improvement.

ARTICLE XX
EXISTING CITY STREET - CONSTRUCTION UPGRADE

Sec. 1. Many of the existing city streets do not conform to the above standards. In many cases, there is inadequate right-of-way and manmade or natural obstructions that preclude significant improvements of the street. In order to accommodate these problems, the following shall apply to all existing city streets.

A. Arterial and Collector Streets: There are no arterial streets in the city at the present time. New construction shall conform to the Design Manual.

B. Local Streets: The specific intent is that existing city streets shall be maintained to a driveable condition approximation their condition at the time of acceptance by the city until such time as increased traffic loading or safety consideration demand and the city can afford to upgrade them to new construction standards. In many cases, it will not be practicable to do so. In these cases, the street will be upgraded by minor grading, overlay asphalt pavements, mitigation of safety issues, and construction of drainage facilities where required. Such upgrades and improvements will be prioritized. The priority shall be set as recommended by the City Engineer and approved by the Board of Alderman.

ARTICLE XXI
EXISTING STREETS - MAINTENANCE

Sec. 1 It is the intent of this guideline that existing city streets shall be maintained in a safe, driveable condition to the maximum extent practicable with consideration given to current available funding and staffing limitations. In general, the roadways will be maintained to the standards at which they were accepted into the city inventory.

Sec. 2 In cases where citizens complaints and staff investigations deems appropriate, the Board of Alderman shall be requested to make improvements to the roadway. This request shall be in the form of a formal request from at least 50% of the persons or businesses located along the street in question. The request will be reviewed by the City staff and the City Engineer and recommended to the Board of Aldermen. In general, improvements will be made only in accordance with the appropriate priority list and when funding is available.

Sec. 3 Snow Ice Removal: There are few existing streets that are inaccessible to city snow plowing equipment. In cases where the street can not be safely plowed by existing city equipment or other safety concern are prohibitive the street will be placed upon a no-plow list at this time the street is accepted into the city inventory. Streets to be placed on the no-plow list shall be recommended by the City staff and approval by the Board of Aldermen. They will remain on the no-plan list until they are upgraded to new construction standards.

ARTICLE XXII
SUBDIVISION ENTRY SIGN

Sec. 1 Entry signs shall be located outside of right-of-way triangles.

Sec. 2 Entry signs located within medians within the right-of-way shall be located a minimum of 10 feet beyond the radius point of the entrance drive.

Sec. 3 No entry signs will be allowed on secondary arterial or greater classification roads.

ARTICLE XXIII
MAILBOXES

Sec. 1 Construction of mailboxes of brick or other non-breakway materia will not be allowed on any roads of collector or higher classification.

ARTICLE XXIV
STORM DRAINAGE CALCULATIONS OVERVIEW

Sec. 1 The City of Forsyth requires the development of a Storm Drainage Plan by a Registered Engineer in the State of Missouri. This plan must include the computation of various drainage quantities, time of concentration, and the design of transport and detention facilities. These guidelines provide the basic criterion for that design.

ARTICLE XXV
STORM DRAINAGE CALCULATIONS

Sec. 1 The storm drainage environment in Forsyth is comprised of hilly terrain with landform either covered by structures, parking or wooded slopes and grass. Rainfalls in the area can be heavy in protracted thunderstorms and will develop substantial runoff and flash flooding. The primary goal of the development of storm drainage facilities in the community is to assure the safety of inhabitants and visitors to the area and to prevent damage to the developed infrastructure. As secondary goal is to reduce the level of pollutants carries in the area lakes.

In general terms the primary means of controlling storm runoff is by collecting and transporting it to the lakes. The use of small detention facilities, velocity control devices, and runoff channels is the preferred methodology. The use of curb and gutters with drop inlets and storm drainage piping for streets and parking areas is preferred.

The following criterion are required for all sub-divisions of four lots or more than two acres, lot development of more than two acres, all street reconstruction projects, and drainage improvement projects.

A. Registered Professional Engineer shall prepare a Storm Drainage plan. The plan shall include the following:

1. Calculate total runoff for the area drained in cubic feet per second. An equivalent twenty-five year storm shall be used with a duration equal to the time of concentration for each area. Channels and open culverts to be designed for one hundred year storm.
2. Calculate the Time of Concentration in minutes for the drained area to reach the point of discharge into the lake or other designed drainage system with a minimum of 5 minutes.
3. Calculate the entrance requirements for all drop inlets or curb inlets in square inches or feet.
4. Calculate the flow conditions at peak flow in storm drainage pipes, culverts, and channels.
5. Calculate the location, vertical and horizontal alignment of all drainage facilities.
6. For developments of more than 1/2 acre in area size a detention basin will be constructed in accordance with this manual.
7. Design culverts to carry the designed flow to suitable outflow channels or facilities.

B. Where grades exceed 5% or exit velocities exceed five feet per second provide an approved energy dissipation device to prevent erosion of soils. The minimum spacing shall be 75 feet.

C. The minimum size culvert shall be 15 inches in diameter. Storm drains or culverts more than 300 feet long shall have manholes set in the line. Manholes or inlets shall be spaced at not more than 300 foot intervals and all bends or changes in grade.

D. Where street grades or ditch lines grades exceed 5% concrete or asphalt paved ditches with paved rundowns shall be required.

E. Where drainage is contained in the gutter section provide drop or curb inlets and rundown as appropriate shall be construction at not less than 300 foot intervals.

F. Design curb cuts and drive entrances to assure that street runoff does not flow into driveways. Mountable curbs or slotted drains shall be utilized as necessary.

G. Drainage ditches in soil with velocities over 5 feet per second shall be lined with engineering fabric, or hard-scaped in rock or concrete.

H. Drainage ditches with velocities over 12 feet per second shall be paved.

Sec. 2 Design storm frequency shall be twenty-five years for all closed storm drainage systems. The design storm for channels shall be the 100 year storm.

Sec. 3 Time of concentration shall be calculated using the following formula:

Kirpich's equation: $Tc = 0.0078\ [L/S^{1/2}]^{0.77}$

Where: L = feet
S = feet per foot
Minimum Tc = 5 min.

Sec. 4 Rainfall intensities shall be taken from the attached table.

Sec. 5 Calculating flow rates: $Q = CIA$

Where: Q = Peak runoff in cubic feet per second (cfs).
I = Rainfall intensity in inches per hour. Obtained from the attached chart.
A = Area of watershed in acres. This area includes the actual area drained through or in addition to the developed area.
C = 0.45 for residential single family areas, 0.80 for non-residential single family areas, shall be used.

Sec. 6 Design of open drainage channels: Drainage Channels shall be designed using the manning equation for open channel flow. The channel shape may be trapezoidal, rectangular, or circular at the designer's discretion. The channel depth shall be designed so that the peak runoff flow (100 year storm) will be accommodated plus 1.0 ft. of freeboard to determine the channel depth. Where channel depth will exceed one foot of trapezoidal section with a maximum of 2:1 side slopes (3:1 slopes are more desirable) shall be used.

Sec. 7 Culverts and Storm Drain Piping Systems shall be designed using open flow non-pressure hydraulics. Pipes shall be designed using inlet-control culvert analysis based on head available at the inlet end of the pipe. Piping systems with multiple pipes can be designed similarly pipe to pipe, or can be designed corporately using computer analysis such as "Storm Cad" by Haestad Methods. Pipes shall be designed to carry the 100% of the peak flow for the design storm (25 year).

Sec. 8 In addition, the following conditions shall be met:

A. The minimum pipe size shall be 15 inches in diameter.
B. Pipe under City streets shall be Class III RCP unless cover dictates Class IV.
C. The minimum pipe slope shall maintain 2.0 feet per second velocity.
D. Inlets or junctions shall be constructed along pipe systems so that the maximum run of pipe does not exceed 300 feet.
E. The first inlets shall be placed where the drainage areas equal one (1) acre for commercial type development, and two (2) acres for residential type development. Inlet capacity must be reviewed for bypass versus interception, bypass flows must be accounted for in subsequent downstream inlets.
F. Provide suitable energy dissipation devices, i.e., riprap or concrete block spillways at inlet and outlet pipes, or elsewhere in channels as required.
G. Piping systems shall be designed to HS-20-44 design loading; pipe class and cover over piping being considered.

TABLE OF RAINFALL DEPTH & DURATION DATA

Duration	Rainfall Intensity, Inches/Hour					
Minutes	2-yr	5-yr	10-yr	25-yr	50-yr	100 yr
5	5.40	6.48	7.23	8.40	9.30	10.20
6	5.19	6.21	6.99	8.08	8.82	9.82
7	4.99	5.98	6.70	7.78	8.60	9.46
8	4.80	5.75	6.46	7.50	8.30	9.10
9	4.60	5.54	6.22	7.22	8.01	8.78
10	4.42	5.34	6.00	6.97	7.71	8.46
11	4.29	5.16	5.79	6.71	7.44	8.16
12	4.13	4.98	5.58	6.48	7.18	7.88
13	4.00	4.81	5.40	6.27	6.94	7.62
14	3.88	4.78	5.24	6.08	6.83	7.40
15	3.75	4.53	5.10	5.91	6.55	7.20
16	3.66	4.42	4.98	5.78	6.41	7.03
17	3.56	4.31	4.86	5.65	6.27	6.89
18	3.48	4.21	4.75	5.53	6.13	6.75
19	3.40	4.13	4.66	5.42	6.02	6.62
20	3.32	4.04	4.56	5.32	5.91	6.51
25	3.00	3.78	4.17	4.89	5.44	5.99
30	2.72	3.38	3.84	4.52	5.03	5.56
35	2.51	3.13	3.57	4.20	4.70	5.18
40	2.32	2.91	3.32	3.92	4.39	4.84
45	2.16	2.71	3.11	3.68	4.11	4.54
50	2.01	2.52	2.91	3.44	3.85	4.26
55	1.88	2.39	2.74	3.23	3.62	4.02
60	1.80	2.28	2.61	3.08	3.44	3.80

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iii. The hydrographs shall be presented graphically or by tabular format through engineering software such as "POND-2".

iv Flood routings shall be made for each design storm, such that flow rates exiting out of the control structure are less than or equal to the existing flow rates as determined.

ARTICLE VII
CALCULATIONS

Sec. 1 Calculations shall be provided for the drainage areas to detention, hydrographs, control structure discharge vs. elevation, detention volume vs. elevation, and flood routings.

ARTICLE VIII
FREEBOARD

Sec. 1 There shall be a minimum of twelve (12) inches of freeboard set from the maximum calculated ponding within the detention areas and the top of detention berm. An emergency spillway can be established at an elevation 6 to 8 inches below the top of berm elevation, set in a location where spillage does not adversely impact downstream conditions of the watershed.

ARTICLE IX
CONSTRUCTION MATERIALS

Sec. 1 Materials shall be appropriate for the use intended and assure stability of the construction and esthetic acceptability at the location proposed. Drainage ditches may be stabilized earth, riprap, concrete, or other durable material. Detention basin inlets, basin, and outlet structures may be of any durable material subject to the approval of the City Engineer. Storm drainage channels may be stabilized earth, concrete or other material subject to approval. All pipes at a minimum must be capable of sustaining an AASHTO HS-20-44 loading. Approved pipe materials include reinforced concrete for all pipe under street paving, per MoDOT section 726 and 1026. For all other locations reinforced concrete or corrugated metallic-coated steel pipe, per MoDOT section 725 and 1020, may be used.

Sec. 2 Construction specifications for the development of streets, parking and storm drains shall be used.

ARTICLE X
TEMPORARY SEDIMENT BASINS DURING CONSTRUCTION

Sec. 1 Storm detention areas shall be used as sediment control basins during the construction activity. Protection devised shall be installed in and about the sediment basin to protect against soil transport downstream out of the project site.

Sec. 2 Detention basins used as sediment control basins shall be cleaned out and restored to design volume upon completion of public improvements.

Sec. 3 The minimum volume to be provided for a sediment control basin shall be 2000 CF (cubic feet) for each acre to be disturbed within the project limits. Areas disturbed for houses or other building/drives/paved areas in lots, etc. shall also be included as areas to be disturbed.

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SECTION V
STORMWATER DETENTION AND SEDIMENTATION DESIGN

ARTICLE I

Unless the context specifically indicates otherwise, the meaning of terms used in this Ordinance shall be as follows:

Sec. 1 "City" shall mean the City of Forsyth, Missouri.

Sec. 2 "Contractor" shall mean any individual, firm, partnership, or corporation hired to construct storm water detention facilities.

Sec. 3 "Developer" shall mean any individual, firm, partnership, corporation, political corporation or subdivision of either the state or federal government who seeks to construct improvements within the City, requiring storm water detention areas.

Sec. 4 "Engineer" shall mean an individual registered as a professional engineer in the State of Missouri.

Sec. 5 "Missouri Department of Natural Resources" (Mo. D.N.R.) shall mean the state agency having jurisdiction over community land disturbance permits, including regulations issued by the Agency.

Sec. 6 "Shall" is mandatory, "should" or "may" is permissive.

Sec. 7 "Superintendent" shall mean the authorized representative of the City, whose responsibility is the inspection and approval of the storm drainage facilities.

ARTICLE II

Sec. 1 That the specification for the construction and maintenance of storm water detention facilities in the City of Forsyth, Missouri, shall be as set forth in this manual which is incorporated herein fully by reference thereto as if set forth herein verbatim.

Sec. 2 That storm water detention facilities in the City of Forsyth, Missouri, will be so constructed as to fully comply with the terms, conditions and specifications.

Sec. 3 That following approval by the Superintendent and certification by the engineer, the City will accept the storm water detention areas for operation. Storm water detention areas shall be constructed within private property, outside of public rights-of-way. Drainage easements shall be established encompassing the entirety of the detention facility; or the detention area shall exist entirely within land designated as common area. Maintenance of detention areas shall be the property owner, or property owners' association.

ARTICLE III

Sec. 1 The developer who requests improvements including storm detention areas shall request and may be granted the right to construct such improvements by the City.

Sec. 2 The developer shall obtain the services of an engineer, who shall prepare design plans for the required improvements. The plans shall be submitted to the City and Mo. D.N.R. for approval prior to beginning any work.

Sec. 3 The developer shall obtain the services of a contractor who shall install the improvements in accordance with the approved plans and specifications. The contractor shall provide a Performance Bond in the City's name to assure completion of the work and a one-year guarantee on the work installed from the date of City acceptance of work.

Sec. 4 The engineer shall prepare the plans in accordance with the following minimum conditions, as identified in the specifications.

Sec. 5 The developer shall be responsible for all cost of engineering, construction and any associated cost resulting from the improvements.

Sec. 6 The City will provide written approval for the improvements. The City reserves the right to not approve any improvements.

ARTICLE IV
STORM WATER DETENTION FACILITIES

Sec. 1 The design of storm water detention facilities shall consider the following:

a. the primary purpose is to maintain or reduce overload flow rates and flow velocities, and
b. to reduce sediment and certain pollutants being carried downstream.

Sec. 2 A rectangular basin shape is desirable where the width is approximately (1/2) one-half the length. It is preferred that the inlet pipe(s) be located on the opposite end from the outlet control structure to reduce "short-circuiting", and provide the maximum detention time within the basin.

Sec. 3 Storm water detention areas shall be constructed within private property, outside of public rights-of-way. Drainage easements shall be established encompassing the entirety of the detention facility; or the detention area shall exist entirely within land designated as common area. Maintenance of detention areas shall be the property owner, or property owners' association.

ARTICLE V
DESIGN METHODS

Sec. 1 Plans for detention facility and calculations shall be prepared by a Professional Engineer, submitted to the City of review and approval prior to any construction of said detention facility.

Sec. 2 Volume of detention shall be provided to reduce developed condition flow rates to less than or equal to the existing condition rates of runoff for the project.

Sec. 3 Detention volumes shall be designed for the individual project site only, however, detention areas located within flow lines of larger overall watersheds need review for channelization of said watershed around or through the proposed detention area.

Sec. 4 The design storms to be used to determine detention volume shall be the 2-year, 10-year and 100-year storms.

ARTICLE VI
METHOD OF ANALYSIS

Sec. 1 Volume of detention for projects 10 acres or less shall be evaluated by the "Simplified Volume Formula", or the Modified Rational Hydrograph Method.

a. Simplified Volume Formula:

V = R x A x Tc (minutes) x 60 (sec./min.)

V = total volume of retention - round up to nearest 1,000 cf

R = differential runoff rate

I_{100} x (Cd - Ce)

where I_{100} - intensity rate for 100 year storm at Tc

Cd = developed condition "C" (impervious cover factor)

Ce = existing condition "C" (impervious cover factor)

A = project area (acres)

Tc = time of concentration - 15 minutes shall be used as the minimum time

b. The outlet control structure must be designed to regulate discharge flow rates to less than or equal to that of the existing conditions for each design storm. Volume of detention may need to be adjusted to maintain existing flow rates leaving the site.

Sec. 2 The Modified Rational Hydrograph Method is defined as follows:

a. Volume of detention for projects 10 acres or greater shall be evaluated by the "Modified Rational Hydrograph Method."

b. Modified Rational Hydrograph Method:

i. Rational based, triangular synthetic hydrographs shall be generated for existing and developed conditions for the project site, for all of the design storms (2, 10 and 100 year).

ii. Hydrographs shall be constructed based on the formulas:

Tc = Tp

Tb - 2.67 Tp

Tc = time of concentration, minimum Tc = 5 min.

Tp = time of peak conditions flow rate, set at Tc

Tb = base of hydrograph or end of flow event where zero (0) flow rate is again achieved

SECTION VI
STREET LIGHTING DESIGN

ARTICLE I
GENERAL

Streets erected within the city limits of Forsyth shall conform to the requirements of Ordinances of the City of Forsyth and the City of Forsyth Design Manual. The design and installation of new streetlights will fall into one of three basic areas:

Sec. 1 New street light in an existing neighborhood on an existing city street.

Sec. 2 Installation of new or additional street lights within an established neighborhood or development.

Sec. 3 Streetlights in a new development for transfer into the city system.

Sec. 4 The city currently operates streetlights in three modes.

Sec. 5 City constructed, maintained and operated on Empire Electric source. This would include lights installed and wired to city standards and accepted into the system. The street light(s) would be on a metered Empire Electric power source with the city paying electricity use bill.

Sec. 6 Empire electric owned, maintained, operated streetlights under current operation agreement with the city. These are existing streetlights currently rented to the city by contract with Empire Electric.

Sec. 7 Empire Electric owned, maintained, and operated streetlights under current operation agreement with the city. These are existing streetlights currently rented to the city by contract with Empire Electric.

Sec. 8 The mode of operation will be recommended by the City Engineer and approved by the Board of Aldermen at time of application.

ARTICLE II
NEW STREETS LIGHTS IN AN EXISTING NEIGHBORHOOD

Sec. 1 If the existing adjacent street lights are Empire Electric fixtures mounted on their poles and rented to the city under a current contact and an existing Empire Electric pole is appropriately located, the street light should be ordered from Empire Electric by the City under the street light contract at the current rate.

Sec. 2 If there is no convenient Empire Electric pole or if the existing system is underground and/or ornamental then three options are available.

a. The applications may contract with Empire Electric to install the approved streetlights at their expense and the City will take over the rental rates for the new lights with prior approval of the Board of Aldermen.

b. The applicant may contract with a private firm to install the approved streetlight wired to the Empire Electric System as approved by the Board of Aldermen. Upon completion, the City would accept the new installation.
c. The City would contract for or construct the requested streetlight when funds are available.
d. The street light design would conform to these specification.

ARTICLE III
INSTALLATION OF A STREET LIGHTING SYSTEM IN AN EXISTING NEIGHBORHOOD

Sec. 1 If the existing adjacent street lights are Empire Electric fixtures mounted on their poles and rented to the city under a current contract and existing Empire Electric poles are appropriately located, the street lights should be ordered from Empire Electric by the City under the street light contract at the current rate.

Sec. 2 If the existing system is underground and/or ornamental, the three options are available.

a. The applicant may contract with Empire Electric to install the approved streetlights of there expense and the city will take over the rent rates for the new lights with prior approval of the Board of Aldermen.
b. The applicant may contract with a private firm to install the approved streetlights wired to either the City system or Empire Electric as approved by the Board of Aldermen. Upon completion, the City would accept the new system.
c. The City would contract for or construct the requested street lighting system when funds are available.
d. The street light design would conform to these guidelines.

ARTICLE IV
STREET LIGHTING SYSTEMS IN NEW DEVELOPMENTS

Sec. 1 The developer shall submit a Street Lighting System Plan conforming to these design guidelines and construct the approved system at his expense. Upon completion and final inspection of the system, the City would accept the system and assume operational costs thereof.

Sec. 2 The mode of operation and wiring system appropriate thereto would be selected by the Board of Aldermen at the time of application for the Building Permit.

ARTICLE V
STREET LIGHTING DESIGN STANDARDS

Sec. 1 Location Requirements:

a. Along the new street at the following intervals:

i. Where intersections on existing or proposed residential or local streets are more than 400 feet apart, lights shall be located at up to 400 feet intervals. Existing lots with a frontage of less than 300 feet shall be exempt.

ii. Where intersections on existing or proposed non-residential or collector street are more than 300 feet apart, lights shall be placed at up to 300 feet intervals. Existing lots with frontage of 200 feet or less shall be exempt.

iii. Where intersections with existing or proposed arterials streets, or US Highway are in excess of 200 feet streetlights shall be placed at intervals up to 200 feet apart. Lighting along all federal and state routes shall meet MoDOT lighting standards.

b. At all intersections.

c. At all turn around areas and dead ends.

d. At all curves of less that 150 feet radius and a delta angle of more than 30 degrees.

e. Streetlights over the traveled way shall be a minimum of 20 feet above the surface.

f. Streetlights located adjacent to the roadway shall be not less than 12 feet high.

g. Streetlight poles shall be located at the outside edge of the city easement or not less than three feet from back of curb or edge of pavement, whichever is the greater.

SECTION VII

WATER DISTRIBUTION SYSTEM

SPECIFICATIONS

1. General
2. Scope
3. Work in Public Thoroughfares
4. Connections to Existing Mains
5. Clearing
6. Hauling
7. Distribution and Storing
8. Installation - General
9. Trench
10. Solid Rock Excavation
11. Pipe Support and Embedment
12. Handling of Water Main Material into Trench
13. Laying Pipe
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15. Deflection at Joints
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21. Pressure and Leakage Test
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28. Cleanup
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WATER DISTRIBUTION SYSTEM
SPECIFICATION

1. GENERAL

A. All applicable work shall be done in accordance with these specifications for materials and construction methods to be utilized by the contractor and shall be considered minimum requirements.

B. References in abbreviation form to standards and other specifications whenever used in these documents shall mean the following:

AWWA	- American Water Works Association
ASTM	- American Society for Testing Materials
AASHO	- American Association of State Highway Officials
ANSI	- American Standards Institute
STATE HIGHWAY SPECIFICATIONS	- Missouri Standard Specifications for Highway Construction, Missouri Department of Transportation

2. SCOPE

A. These specifications shall apply to the installation of all pipe, fittings, valves, hydrants, service and meters included in the water distribution system. Specific materials to be used shall be set forth on the plans.

3. WORK IN PUBLIC THOROUGHFARES

A. All work by the contractor in public thoroughfares shall conform to the specifications and requirements of the authority having jurisdiction, (e.g., State Highway Department, County Court, Special Road District, District, etc.). Any method or manner of work of the contractor resulting in conditions unsatisfactory to the governing authority shall be discontinued and the contractor shall immediately commence work in an approved manner to correct any conditions of the work in progress so disapproved. Excavations across streets or in street intersections shall be made to keep one lane open to traffic at all times, if possible, and he shall notify and make arrangements with the proper authority in advance.

B. The contractor shall maintain proper and sufficient barricades, lights and warnings on and near trenches and obstructions in safeguard against injury and damage. The contractor shall promptly backfill or satisfactorily barricade any open ditch which is an unnecessary hazard.

C. All work by the contractor shall be done in such a manner that a minimum of inconvenience will result to pedestrian and vehicular traffic and to occupants of property along the routes of the mains and lines to be laid, and the contractor shall, in all respects, use his best efforts to preserve, maintain, and foster good will and amiable relations with all residents and property owners along the route of such water mains and lines.

4. CONNECTIONS TO EXISTING MAINS

A. The contractor will make tie-ins and/or taps onto existing live water mains under the supervision of the City, using approved equipment and materials. The contractor shall not operate any valves, fire hydrants, blow offs, or similar equipment on the existing water system of the utility. The City will arrange for personnel for valve operation as required. If it should be necessary for the water supply of any customer to be turned off, it shall be done only with the approval of the City, and it shall be the responsibility of the contractor to notify all customers to be affected at least twenty-four hours in advance of such and the anticipated duration thereof. If, it is not practical or advisable to have the water off in the existing system for such purpose during regular working hours, the contractor shall schedule such work, on overtime if necessary, at a time approved by the City.

5. CLEARING

A. The Design Engineer will establish the construction limits and will designate all existing structures above the ground, trees, shrubs, and plants that are to remain. The contractor shall preserve without damage these items throughout the construction period. Minimum clearing is required.

B. Trees, stumps, brush and hedge within the construction limits that are not designated to remain shall be cleared and grubbed only to the extent required for the installation, with debris completely removed from the site and disposed of by the contractor.

C. Existing structures, including but not limited to, pavement, curbs, sidewalks floors and similar objects where portions of these objects are to be left in place, shall be removed to an existing joint or a new joint sawed to a minimum of one inch (1") with a true line and vertical face. Sufficient portions of such objects shall be removed to at least six inches (6") behind the trench width. The debris resulting shall be removed from the site and disposed of by the contractor.

6. HAULING

A. All pipe, fittings, valves, hydrants and accessories shall be loaded and unloaded by lifting with hoists or skidding to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

B. All materials received at the job site shall be carefully inspected for damage in transit. Damaged materials shall be so marked and removed from the site as soon as possible.

7. DISTRIBUTION AND STORING

A. All materials and equipment used in the construction project shall be so placed so that they will not injure the public or private property and also all fire hydrants, fire and police alarms, mail boxes, water valves, and other utility and sewer manhole and vault covers in the vicinity shall be freely accessible at all times. All pipe shall be loaded, hauled, unloaded and distributed in such manner as to not injure or damage the pipe or the coating thereon. In hauling pipe, each length must be protected by pads from contact with the truck. Slings of canvas, leather or other materials acceptable to the Engineer may be used in the handling of the pipe, but chains, cable and rope shall not be used in any manner to contact and injure the coating.

B. In case of injury to the protective coating or lining on the materials, the contractor shall repair at his expense such injury and shall replace the coating or lining so that the coating or lining shall be in as good condition as it was prior to injury. The city will determine if replacement is required.

C. Distribution of materials shall be kept to a minimum ahead of construction. Pipe placed along the route shall be a maximum of that anticipated for two working days' need. Placement shall be such that the pipe can not be contaminated with surface water, dirt, other materials. Pipe shall not be laid in ditches. Valves, fittings, hydrants shall be distributed a maximum of one day ahead of their anticipated installation.

8. INSTALLATION - GENERAL:

A. The water main shall be laid and maintained to the required lines and grades with fittings, valves, and hydrants at the required locations; spigots centered in bells; and all valves and hydrant stems plumb. Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere to such an extent that an alteration in the plan is required, the city shall have the authority to change the plans and order a deviation from the line and grade or arrange with the owners of the structures for the removal, relocation, or reconstruction of the obstructions. The trench shall be so braced and drained that the workmen may work therein safely and efficiently. It is essential that the discharge of the trench dewatering pumps be conducted to natural drainage channels, drains or storm sewers.

B. The contractor shall comply with all laws regarding the construction activities including the notification of all other utility companies through the appropriate statewide notification system.

9. TRENCH:

A. The width of the trench shall be ample to permit the pipe to be laid and jointed properly, and the backfill to be placed and compacted as specified. Trenches shall be of such extra width, when required, to permit the convenient placing of timber supports, sheeting and handling of specials. The width in solid rock shall be such that future repairs can be made to the pipe without solid rock removal. A minimum width shall be 14 inches, or the pipe diameter plus 8 inches except in rock where 12 inches plus the pipe diameter is required.

B. The trench shall be excavated to a depth required to provide a uniform and continuous bearing for the pipe bedding and pipe. A minimum pipe cover of 3.5 ft. shall be provided except where solid rock excavation is required with 2.5 ft. of cover to be provided. Any part of the trench bottom which is over excavated shall be backfilled with bedding rock to insure consistent bearing for the pipe. The finished subgrade and resulting bedding grade shall have a uniform grade and width to allow proper placement of the pipe. Changes in alignment in either the vertical or horizontal plane where bends are not required shall be made by beginning the trench transition such that a smooth curve is obtained which will allow the pipe to be installed without placing the pipe in a stressed condition or exceeding the pipe joint allowed deflection angle. The contractor shall notify the City when he feels the change in alignment requires a fitting rather than deflection of the pipe at the joints. Where the bottom of trench at subgrade is found to be unstable or to include ashes, cinders, all types of refuse, vegetable or other organic materials, or large pieces of fragments of inorganic materials which, in the judgement of the City should be removed, the contractor

shall excavate and remove such unsuitable material to a depth of two feet (2') below the subgrade at full trench width. Before the embedment material is placed, the subgrade shall be made by backfilling with bedding rock material.

C. Subgrade in Rock Trenches: Where excavation is made in rock, the clearance shall be six (6") inches minimum below the pipe.

D. Subgrade in Earth Trenches: Where excavation is in earth the clearance shall be four (4") inches below the pipe.

E. The contractor may remove and separate the top soil or elect to obtain the required topsoil from another source for use in restoration.

10. SOLID ROCK EXCAVATION:

A. Solid rock shall be defined as such material that cannot be excavated without drilling and blasting, wedging, sledging or barring. Stones, boulders, or underground concrete segments ten (10) cu. ft. in volume or greater, shall be classified as solid rock.

B. Whenever rock is encountered in the trench and excavation is required to be made, the contractor shall excavate the same using methods generally accepted by the construction industry for the specific site. Where drilling and blasting is used, the contractor shall provide proof of proper blasting insurance in effect at the time of the work and conduct a pre-blast survey of all surrounding structures which might be damaged, and operate a seismograph to indicated and record ground movements due to blasting. The record of monitoring shall include location, day, time, and an event log.

11. PIPE SUPPORT AND EMBEDMENT:

A. The barrel of the pipe shall be supported by clean, crushed rock bedding material with a minimum thickness of 4". The contractor shall then embed the pipe with bedding stone to a point at least 6" over the top of the pipe.

B. All bedding stone material used shall have the following gradation:

Percent Passing	Sieve Size
100	3/8 inch
95 - 100	No, 4

12. HANDLING OF WATER MAIN MATERIAL INTO TRENCH:

A. Proper implements, tools, and facilities satisfactory to the City shall be provided and used by the contractor for the safe and convenient prosecution of the work. All pipe fittings, valves, and hydrants shall be carefully lowered into the trench piece by piece by means of a derrick, ropes or other suitable tools, or equipment, in such manner as to prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water materials be dropped into the trench.

13. LAYING PIPE:

A. Pipe shall be laid with bell ends facing in the direction of laying unless directed otherwise by the City. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. If the pipe laying crew cannot put the pipe into the trench and in place without getting earth into it, the City will require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

B. After placing a length of pipe in the trench, the spigot end shall be centered in the bell and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved embedment material tamped under it. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipe and fittings of proper dimensions to insure such uniform space. Precautions shall be taken to prevent dirt from entering the joint space. A suitable wood blocking shall be used to force the joint together using a pry bar. Using a backhoe bucket shall not be allowed to join the pipe.

C. The contractor shall install a "locator" tape in the trench above the bedding. adjacent to the pipe. The tape shall be looped along the lead to each fire hydrant and exposed at the hydrant traffic flange.

D. At the conclusion of each day's work or any other significant delay in the pipe installation, a slip joint cap shall be placed on the end of the pipe. If groundwater or threat of rain is expected, the end of the pipe shall be supported in a manner that water cannot enter the pipe at the cap unless the cap has a watertight joint.

14. CUTTING PIPE:

A. The cutting of a pipe for inserting valves, fittings, or closure pieces shall be done in a neat, workmanlike and approved manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe.

B. The cutting of pipe shall be by means approved by the pipe manufacturer and shall result in a smooth, square pipe end with proper taper for the joint system.

15. DEFLECTION AT JOINTS:

A. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane to avoid obstructions or plumb stems, or where long radius curves are permitted, the amount of deflection allowed shall not exceed that required for satisfactory jointing of the joint, and shall be approved by the Engineer and manufacturer's recommendations.

16. VALVES:

A. Valves, fittings, plugs and caps shall be set and jointed to pipe in the manner heretofore specified for cleaning, laying and jointing pipes. Valves in water mains shall, where possible, be located on the street property lines extended unless shown otherwise on the plans. A valve box shall be provided for every valve which has no gearing or operating mechanism or in which the gearing or operating mechanism is fully protected with a cast iron grease case. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the wrench nut of the valve, with the box cover flush with the surface of the finished pavement or such other level as may be directed by the City.

B. Valves shall be set on bedding stone material. Valves 4" and larger shall be anchored by placing concrete on each side of the valve and tied down by 2 - #4 rebars over the top of the valve and set in the concrete.

17. DEAD-ENDS:

A. All dead-ends on new mains shall be closed with plugs or caps, with a hydrant installed, as shown on the drawings.

18. ANCHORAGE FOR PLUGS, CAPS, TEES AND BENDS:

A. All plugs, caps, tees and bends deflecting horizontally 11-1/4° or more on mains two inches (2") in diameter or larger shall be provided with a reaction backing so movement shall be prevented under operating pressure conditions.

B. All bends vertically shall be anchored and tied down to concrete placed to each side of the fitting using 2 - #4 rebars. The trench shall be widened to allow placement of concrete on each side of the fitting which provides a minimum surface area of 4 ft.^{2} and 1/3 cubic yard of concrete to each side of the fitting.

C. Reaction backing shall be concrete having a compressive strength of not less than 2,500 psi at 28 days. Backing shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that shown on the plans. The backing shall, unless otherwise shown or directed, be so placed that the pipe and fitting joints will be accessible for repair. When, in the opinion of the City, the concrete used for reaction backing is of questionable strength, the contractor shall remove and replace the backing or demonstrate the backing has required strength.

19. FIRE HYDRANTS:

A. Fire hydrants shall be furnished and installed by the contractor as called for on the plans. Fire hydrants shall be installed plumb with pump nozzle toward the street or pointed toward street. Bury line of fire hydrant shall coincide within three inches (3") with finished grade or hydrant shall be replaced with a shorter hydrant or increased in height by addition of an extension as required. Field painting or repainting as provided in materials specifications is required before acceptance. They shall be covered with a secured burlap sack until main is in service.

B. A drainage pit 2' by 2' and 2' below the bottom of the hydrants shall be excavated and then refilled completely with coarse gravel or broken stone, properly placed under and around the bowl of the hydrants and up to a level of 6" above the waste opening. Each hydrant shall be set on a flat precast concrete slab 16" x 16" x 4" and the hydrant, when set, shall be plumb and well braced against unexcavated earth at the end of the trench with concrete reaction backing.

20. BACKFILLING TRENCHES:

A. Complete trench backfill shall occur promptly after the pipe, bedding, and embedment have been completed. Prompt backfilling behind trench excavation and pipe laying operation shall take place. Length of an open trench shall not exceed 150 feet. Intersecting streets shall be open to traffic at end of work day. At the end of each days work, the trench shall be backfilled to a distance of 10 feet from the end of the pipe. Barricades around open trenches shall be provided when work is not underway.

B. Backfill over backing blocks or anchoring shall occur when concrete has attained one (1) day strength.

C. Backfill above the pipe embedment shall be with suitable materials excavated from trench and processed as required, or borrowed from locations arranged for by contractor. Material shall be free from organic matter, refuse, ashes, cinders or other unsuitable material, and shall not be frozen. Material shall be free from gravel, stone or shale particles greater in any dimension than one-half the depth of layer to be compacted or 6 inches. Backfill material shall contain sufficient fines to provide a dense mass capable of being compacted. Backfilling shall be done in a manner such that materials are placed at an angle to the trench. Right Angle (90°) to the trench backfilling should not be done. 45° angle backfilling should provide a sloping fill face to minimize damage to the pipe and obtain a better compaction.

D. Backfill materials placed under road beds, roadway crossings, paved parking lots, and paved drives shall be crushed stone for the entire depth of trench.

E. Compact materials at or near optimum moisture content as determined by the Engineer. Compact with equipment and by methods which will prevent settlement and obtain the specified density. Density of compacted backfill materials shall be as follows:

(1) Embedment material -- 95%. Accomplish by spading, rodding and foot traffic to an approved condition. No testing is necessary.

(2) Material above the embedment material when trench is under paved roadways or driveways, 95% minimum -- compact to prevent future settlement as determined by the Engineer.

(3) Material above the embedment, 85% minimum to prevent future settlement.

Maximum density shall be determined by the AASHO Standard Methods.

F. Trenches under existing concrete or asphalt paved roadway crossings, parking lots, and driveways shall be backfilled as specified above to within two (2) inches of the original surface. Where high traffic volume and speed do not allow base rock to be used as a temporary surface, fill final two (2) inches with an approved cold-mix asphalt to permit traffic for the intervening period between backfilling and pavement replacement. Trenches under low type bituminous surface or gravel roadways shall be backfilled and the surface repaired with gravel until final repairs are made. Maintain surface as necessary until final acceptance. Maintain backfilled trenches not in paved area as required and directed. All trench settlements shall be corrected prior to acceptance and through the guarantee period.

G. Trench lines on easements and vegetated areas shall be graded smooth immediately after backfilling. Excess materials from the excavating, clearing, etc., shall be removed, except for a reasonable windrow of select backfill material left to one side of the trench. Following sufficient weathering and trench settlement, any excess material shall be removed prior to final grading and seeding. Areas subject to erosion shall be graded smooth and seeded and mulched within 7 days of backfilling.

21. PRESSURE AND LEAKAGE TEST

A. Before applying the specified test pressure, all air shall be expelled from the pipe. If hydrants or blow-offs are not available at high places, the contractor shall make the necessary taps at points of highest elevation before the test has been completed. Saddles and corporation stops shall be used at these high points and left in place.

B. Any cracked or defective pipes, fittings, valves, or hydrants discovered in the consequence of this pressure test shall be removed and replaced by the contractor with sound material in a manner satisfactory to the Engineer and the test repeated. Test pressure is to be held for a period of not less than two hours.

C. Test pressure shall be as determined by the following formula:

$$P = \frac{(TOE - GE) \times 1.50}{2.31}$$

P = Testing pressure in psi at elevation of gauge w/minimum 125 psi.

TOE = Tank overflow elevation.

GE = Elevation at centerline of gauge

D. No water main or section thereof will be accepted if and while it has a leakage rate in excess of that determined by the following formula:

$$L = \frac{ND(P)1/2}{7400}$$ in which

L = Maximum permissible leakage in gallons per hour

N = Number of pipe joints in the line under test

D = Nominal internal diameter of the water main being tested in inches

P = Average actual pressure in psig in the water main

Perform test by holding pressure for two hours and measuring the amount of water lost by use of meters or other methods approved by City. Tests are to be made with the City present.

E. If test indicates leakage greater than that specified, the defective pipe, joint, or joints shall be located and repaired, with tests run again after correction is made to pipe.

F. Contractor is to furnish all necessary labor, materials and equipment for testing and shall stand the expense of water wasted through testing. Each line segment between main line valves shall be tested.

G. All pipe, fittings, valves, hydrants, service connections shall be tested.

22. DISINFECTION

A. The contractor shall perform the disinfection of water mains. The method will be performed in accordance with AWWA C651-(latest edition). All cost in connection with the disinfecting operation shall be at the expense of the contractor.

B. Perform disinfecting operations after hydrostatic tests have been completed and separately on segments of the lines between isolation valves. Disinfecting shall not be performed until all line segments are ready for disinfecting, including successful pressure and leakage testing and the lines sufficiently flushed to remove all mud, dirt and other debris.

C. Applied chlorine shall be in the form of liquid chlorine gas-water mixture or high-test calcium hypochlorite (65% Cl). High-test calcium hypochlorite shall first be made into a paste and then thinned to approximately a 1% chlorine solution, which requires one pound of compound mixed with 8.0 gallons of water.

D. Application of chlorinating agent shall be at the beginning of the segment being tested through a corporation stop inserted for the purpose. Apply at rate of approximately 25 ppm or as required to produce 10 ppm after 24 hours standing.

E. The contractor shall perform all flushing and sampling required to put the mains and runs into service by the methods allowed: Filling velocities shall not exceed one foot per second. Samples for bacteriological testing shall be delivered to the Missouri Division of Health Laboratory or other approved laboratories for analysis. Two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the main. At least one set of samples shall be collected from every 1,200 ft. of new main, plus one set from the end of the line and at least one set from each branch. Samples shall be collected from a corp stop and copper-tube gooseneck assembly.

F. No usage of water from a new main for any purpose shall occur until disinfection is completed and accepted.

G. Treated water shall be retained in the pipe long enough to destroy all nonspore-forming bacteria. This period shall be at least 24 hours and shall produce no less than 10 ppm at the end of the line segment. The contractor shall provide a suitable test kit to check the chlorination concentration.

H. Sample cock assemblies shall be furnished, installed and removed by the contractor at the end of the main segment to be disinfected. The corporation cock will be removed and replaced by a brass plug. A temporary blow-off shall be provided at the end of the main being sterilized to provide a means of flushing if a hydrant is not available. Upon completion of the sterilization process, the blow-off shall also be removed. Sampling from a hydrant will not be allowed.

I. Following disinfection, flush treated water from line at all extremities until replacement water is tested to be of comparable quality to that in existing mains. The City will fill the main the first time for this particular test; any subsequent filling of main will be at the contractor's sole cost for water used at regular rates. Tests for quality shall be taken at least two days after flushing. Should initial treatment fail to result in conditions specified, the contractor shall repeat original chlorination procedure until satisfactory results are obtained.

23. BLASTING

A. All blasting is performed at the contractor's sole risk. The contractor is solely responsible for any and all damages caused by blasting to any adjacent structure or any other underground facility. Extreme care should be exercised when paralleling or crossing other underground facilities.

24. BORING AND CASING

A. The contractor shall make boring and casing crossings where shown on the plans. The contractor shall pay fees and obtain permits for the crossings and shall comply with all requirements of the Highway Department crossed. The contractor shall furnish all pipe, pipe encasement, boring equipment, timbering, shoring, bracing, rock excavation and other labor materials required and shall receive no additional payment for extra items involved. Casing pipe and carrier pipe shall be installed in accordance with the Highway Department.

B. Casing pipe and joints shall be constructed from new steel, having a minimum yield strength of 35,000 psi. Joints shall be leak proofed by welding. Pipes under highway crossing shall have the following wall thickness: 16" and under, 0.188"; 18", 20" and 22", 0.250".

C. Casing Pipe Installation: Casing pipe shall be jacked or installed in an auger-bored hole to the line and grade required by the plans. Holes 2" in diameter larger than the casing shall be filled with cement grout or sand.

D. Carrier Pipe Installation: The carrier pipe shall be placed in the casing using temporary wood shims and then filled with sand for permanent support under the pipe. Complete filling of casing with sand is not required. Manufactured 14 gauge S.S. band and high density polymer runner casing spacers, 3 per pipe section or a 10 foot maximum spacing,

may be used in place of the wood shim, sand, and concrete. Concrete cradle shall be placed with the pipe where it enters and leaves the casing. Bore pits shall be backfilled with crushed rock up to the bottom of the pipe to provide a firm support and prevent settlement and damage to the pipe.

25. OTHER UTILITY CROSSINGS

A. Extreme care shall be taken in crossing or paralleling water, sewer, gas, and other utility lines. If solid rock is encountered in such areas, no explosives shall be used. The contractor shall be fully liable and shall pay full cost of repairing any damaged facility.

B. The contractor shall fully comply with all rules and regulations as set by the Missouri Department of Natural Resources when crossing or paralleling existing sewers including:

1. Water mains shall have at least 10 feet horizontally separation from any existing or proposed sewer. In cases where it is not practical to maintain a ten foot separation, the Engineer may allow deviation on a case-by-case basis. Such deviation may allow installation of the water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer and on either case, at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.

2. Water mains crossing sewers shall be laid to provide a minimum vertical clear distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. At crossings, the full length of water pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

C. The contractor shall notify all utility companies of the proposed work and make the necessary arrangements for the marking of all parallel or crossing of adjoining utilities. The minimum notification shall be through the Missouri One Call system.

26. FENCES AND GATES

A. Before proceeding with construction operations, contractor shall furnish and install suitable, substantial gate or gap in every fence at intersection with right-of-way for access to land crossed by pipeline and for passage of construction equipment. Fences shall be reinforced as necessary to prevent damage. If woven wire fences or chain link are encountered, they must not be cut unless contractor obtains written consent of owner and tenant and adequate arrangements are made for bracing and rebuilding. Fences shall not be cut but taken down at the corner post unless the crossing point is more than 100 feet from the corner post. Contractor will replace fences to their original location and conditions upon completion of the line segment.

B. Contractor shall be responsible for keeping gates closed at all times during performance of work. Contractor shall be responsible for any damage resulting in leaving gates open or slack fence caused by improperly installed gate.

C. Fence repairs shall be in a workman like manner including the use of fence splices designed for the repairs to be made. Fences taken down by the contractor which are not suitable for replacement shall be replaced with new materials.

27. GRADING AND SEEDING

A. All disturbed lawn, pastures, and other non-paved grass areas shall be graded and seeded as follows:

After the trench backfill has been compacted, the excavated area shall be covered with at least 2" of top soil free of rock larger than 1" in largest dimension and noxious weeds or seeds. Pastures or other non-lawn type areas will not be required to have top soil added unless a stand of grass in not possible without top soil. Before final raking, areas to be seeded shall be fertilized with a mixture containing 13 lbs. each of soluble nitrogen, phosphoric acid and potash per 100 lbs. by spreading evenly at the rate of 12 lbs. per 1,000 sq. ft. of area using a mechanical spreader of the rotary type. The area shall then be raked to a smooth even surface, the soil loosened to a depth of at least 1" and seeded.

The seed mixture shall be the type of grass that exists in that vicinity. In those areas where the variety of grass cannot be determined, the seed mixture for maintained lawn areas shall be as follows and shall be evenly distributed over the area at the rate of 6-8 pounds per 1000 square feet, using a mechanical seeder.

Variety	Mixture	Purity	Germination
Turf Type Tall Fescue	100%	95%	90%

The following seed mixture shall be used in all other areas such as fields, pastures, roadside ditches, etc., and shall be evenly distributed over the area at the rate of 33 pounds per acre (1 pound per 1000 square feet), using a mechanical seeder.

Variety	Mixture	Purity	Germination
Kentucky 31 Fescue	90%	95%	90%
Annual Rye Grass	10%	98%	90%

All seed shall be free from Johnson grass, Canadian thistle or field bindweed seed, and shall be from the previous years seed crop.

All reseeded areas shall receive straw mulch at a rate not less than 100 pounds per 1000 square feet.

Reseeding of disturbed areas shall be accomplished as the construction work progresses, during the next available Spring or Fall seeding period. No seeding shall take place from November 1 through April 1 and from June 1 through August 15.

No seeding shall be done when the ground is frozen, wet, or otherwise in a non-tillable condition.

All lawn and landscaping shrubs, bushes, and small trees that are removed during construction shall be replaced to their original conditions.

The contractor shall guarantee a stand of grass and shall protect all landscaping work against damage until completion and final acceptance of the work.

B. All pavement which has been removed during the course of construction or which, in the opinion of the City, has been damaged during the progress of the work shall be replaced with the same type as the original paving. The required repairs shall be made by the contractor for damage to roadways resulting from construction or the contractor's use during construction.

(1) Prior to placing the final roadway surfacing, the top twelve inches (12") of backfill shall be further compacted to obtain at least 95% of maximum density, any loose surfacing removed, and a straight edge established by sawing the remaining surfacing, 12" back of the trench lines.

(2) The contractor shall make the final pavement repairs. Final pavement repairs shall include adding of base material, grading and compacting of the base to obtain the specified quantities, roadway cross-section and alignment prior to placing the road surfacing. The specified roadway surfacing shall be placed following approval by the City of the subgrade and base. All work and materials shall be in accordance with the latest edition of the "Missouri Standard Specifications for Highway Construction" and as noted in the plans. Final pavement repairs shall be approved by the City following testing and inspection.

28. CLEAN-UP:

A. All work by the contractor shall be done in a neat, workmanlike manner, and the right of way and adjacent ground shall be cleared of rubbish, brush, rock, trash and excess dirt immediately after pipe is laid and backfilled. The contractor shall promptly backfill or satisfactorily barricade any open trench which is an unnecessary hazard. All surplus materials furnished by the contractor and all tools and temporary structures shall be removed from the site by the contractor. All dirt, rubbish and excess earth from the excavation shall be hauled to a dump provided by the contractor and the construction site left clean to the satisfaction of the City. When the water main segment is completed, the contractor shall restore the ground (including any prior surface preparation) and adjacent property to their condition prior to the construction project.

29. FINAL INSPECTION AND ACCEPTANCE:

A. The contractor shall notify the Design Engineer and City when the construction project is ready for final inspection. Within ten days after such final inspection, the Engineer shall notify the contractor and City in writing of any defects or defaults in performance which may have been discovered upon such final inspection. The contractor shall remedy promptly all such defects or defaults and again notify the Engineer and City when the project is ready for another inspection. This process shall continue until the project shall be accepted by the City.

30. MATERIALS:

A. General: Only approved materials, conforming to the requirements of these specifications, shall be used in the work. They may be subjected to inspection and tests at any time during their installation or use. Prior approval of shop drawings, source of supply, and/or material samples, as may be applicable, must be obtained from the City before delivery or use. Representative preliminary samples of materials shall be submitted by the contractor when required for examination and tests. Materials shall be stored and handled to insure the preservation of their quality and fitness for use and shall be located to facilitate prompt inspection.

B. Pipe: Where the plans specify Ductile Iron Pipe (D.I.P.) this material shall be used. Where the plans specify Polyvinyl Chloride Pipe (PVC) this material or D.I.P. may be used.

(1) Polyvinyl Chloride Pipe (PVC): The pipe shall be manufactured of Type 1, Grade 1, 2000 psi design stress compound designated as PVC 1120 and will conform to ASTM D-1784, Class 12454B compound specifications. SDR21, Class 200 shall be used as shown on Proposal Form for pipes 1-1/2" in diameter and larger. It shall bear the National Sanitation Foundation (NSF) seal of approval and shall conform with the requirements of ASTM D-2241. The pipe shall have one end tapered for use with gasketed bell end and shall be in 20 foot lengths. The bell portion of pipe to be an integral homogeneous part of the pipe for 1-1/2" and larger. The use of white PVC pipe is preferred to reduce heat generated by sun rays, thereby accommodating outside storage. Pipe other than white PVC must be stored under cover. The PVC pipe shall be sealed against leakage by means of a rubber ring seated in the pipe bell. The joint shall have a positive pipe stop that will automatically and accurately position the pipe end within the bell. The pipe stop shall also permit the thermal expansion of recontraction of the pipe. PVC pipe shall be equal to J-M, Cantex, Certainteed, Diamond, or approved equal. A certification of compliance shall be provided by the manufacturer.

(2) PVC: For PVC pipe with diameter less than 1-1/2", the pipe shall be manufactured in accordance with section B(1) above. The pipe shall be Schedule 80 with solvent welded joints.

The solvent cement and primer shall be designed for the pipe material used. The joint shall be made following the manufacturer's recommended procedures and materials.

(3) Ductile Iron Pipe (D.I.P.): All ductile iron pipe shall be manufactured per ANSI A21.51 (AWWA C151), latest revision. Minimum pressure class shall be 350 psi for 12 inch or less. The minimum pressure class shall be provided unless otherwise required by the detailed plans. The pipe shall be cement mortar lined with bituminous seal coat in accordance with ANSI A21.4 (AWWA C104). Pipe joints shall be push-on type with gaskets conforming to ANSI A21.11 (AWWA C111), unless otherwise required by the detailed plans. All pipe shall be marked by the manufacturer to indicate class. The pipe manufacturer shall provide a certification regarding compliance with the specifications. Nominal pipe laying lengths shall be 18 or 20 feet per joint.

(4) Water Service Pipe: Water service pipe shall be used between the corp stop on the main and meter location. Service pipe shall be Sch. 80 PVC, in accordance with Section B(1) above.

C. Fittings: Where the plans specify a particular material and joint type this shall be provided. All fittings 4" and larger shall be cast or ductile iron.

(1) Cast Iron or Ductile Iron (Noted as "MJ" on plans): Fittings shall conform to ANSI A21.53 (AWWA C153) or ANSI A21.10 (AWWA C110) for standard or compact with mechanical joint. Fittings shall have a bituminous manufacturer applied exterior coating. Fittings shall have a manufacturer applied cement mortar linings with bituminous coating. Joint gaskets shall be designed for use with the type of pipe being used. Fittings shall be complete with bolts, nuts, glands, and gaskets.

(2) P.V.C. Fittings: Unless noted otherwise, all fittings 2" or 3" shall have flexible elastomeric seals (gasket) conforming to ASTM D-3139 and ASTM F477. The PVC compound shall conform to ASTM D1784. Fittings shall be designed for use with PVC pipe produced in compliance with ASTM D-2241, SDR-21, including materials dimensions and pressure rating. All fittings shall be approved and marked as to manufacturer and NSF approval. Fittings shall be equal to Harco, Head, Spears, or approved equal.

(3) P.V.C. (1-1/2" and Smaller): PVC fitting shall conform to ASTM D- 1784 for injection molded with compound meeting the requirements of cell classification 12454A, but modified for the production of high impact strength fittings. All materials used shall be approved for use by the National Sanitation Foundation Laboratories. All fittings shall bear the company name or trademark, material designation, size, applicable IPS schedule and the N.S.F. seal of approval. Fittings shall be heavy duty schedule 80 conforming to ASTM D-2467 with solvent welded joint system unless otherwise noted. Threaded pieces shall be standard iron pipe thread. The solvent cement and primer shall designed for use with Type 1 PVC. No thinner will be allowed. Joints shall be made following the recommended procedure of the manufacturer. PVC fittings shall be equal to Harco, Head, Spears, or approved equal.

D. Gates, Valves, Valve Box, and Miscellaneous:

(1) Gate Valves (2" and larger): All gate valves 2" and larger shall conform to the latest specifications of AWWA C509, 200 psi rated and shall be tested to 400 psi without leakage in the factory. The valve body shall be cast iron with mechanical joint with glands and gaskets as required by the pipe material as called for on the plans. Valves shall be non-rising stem type with 2" square operating nut, "O" ring seals, thermoplastic anti-friction washer, thrust collar. Stem and stem nut shall be bronze. Space between "O" rings shall be filled with lubricant to permanently lubricate the thrust collar and "O" rings. The bronze stem nut to be cast integral with the valve disc. Valve shall open counter-clockwise.

The valve shall use a modified wedge disc and a resilient rubber seat ring. The valve disc shall travel along a machined surface in the valve body with solid guide lugs on the disc. The disc shall be designed to prevent solids build-up in cavities. The seal ring shall be replaceable and mounted to the disc with stainless steel screws. The valve body shall be machined to provide a sealing surface for the resilient seat and provide drip- proof operation regardless of flow direction.

The valve interior shall be fully protected by a two-part thermosetting epoxy coating conforming to AWWA C550. A standard bituminous exterior coating shall be provided.

Gate valve shall be equal to Mueller, Kennedy Ken-Seat, American Series 2500, Clow, U.S. Pipe, or approved equal.

(2) Gate Valve (smaller than 2"): All gate valves smaller than 2" shall conform to Class 200 bronze ASTM B-62 with handwheel, NRS, threaded pipe connection. Valves shall open counter-clockwise.

(3) Valve Box: All valves installed shall have provided and installed a cast iron valve box. Valve boxes shall be two piece, screw type, with lid marked "water". Each box shall be designed for the valve bury depth. Extensions may be required for extra depth of bury. The valve box shall have a shaft inside diameter of 5-1/2" for valves 4" and larger and 4-1/4" inside diameter for 2" valves. Valve boxes shall be bituminous coated inside and outside.

E. Fire Hydrants:

(1) Three Way Hydrants: Shall be cast iron body, fully bronze mounted, suitable for a working pressure of 150 pounds per sq. inch and shall be in accordance with the latest specifications of the AWWA C502 for dry barrel hydrants. Hydrants shall have two 2-1/2" and one 4-1/2" for 3-way hydrants (NST) hose nozzles, self-oiling dry top bonnet, safely flanged and stem, "O" ring seals, compression opening, fully painted and coated for appearance and corrosion protection. The hose nozzles shall be replaceable and threaded into the body of the hydrant. Depth of bury shall be determined by the contractor for each location with a minimum of 4 feet. Inlet connections shall be 6" as noted with mechanical joint connection complete with gland and gasket required by the type of the pipe being used. The hydrant main body valve shall be 5-1/4".

All hydrants shall have a weather shield at the top of the operating nut to protect the clearance area between the top casting and the operating nut. The operating nut shall be a one-piece bronze casting; both the operation nuts and nozzle caps to be a pentagon shape and measure 1-1/2" from point to flat. Caps to be provided with rubber gaskets and retaining chains. Hydrant nozzle section shall be capable of rotation through 360 degrees with respect to the standpipe.

Hydrants shall have identification mark indicating direction of opening. Hydrants shall have permanent markings identifying the manufacturers name and size of main valve opening and year of manufacture.

Hydrants shall have an automatic drain that is operated by the main valve rod. Drain valve is to open as the main valve is closed and close as the main valve is opened. The port and seat of the main valve is to be bronze. The bronze valve seat shall be threaded into a bronze drain ring or shoe bushing to prevent electrolysis between these components. The drain channel shall be all bronze. The hydrants shall have two drain outlets above the lower flange of the hydrant shoe assembly.

The hydrants shall be designed to permit the use of extension sections and allow all parts to be removable from ground level without requiring excavation of the hydrant.

The outside of the hydrant top section shall be painted a minimum of one coat of primer and one finished coat of enamel. The internal surface of the shoe shall be coated with a factory applied two part, thermosetting epoxy coating with a minimum thickness of 4 mil.

Hydrants shall be equal to Mueller Centurion, Kennedy Guardian, American-Darling B-84-B, Clow Medallion, U.S. Pipe, or approved equal.

F. Service Saddle: Bronze service saddles shall be provided at each meter service and other locations noted on the detailed plans. The service saddle shall be designed for use on the type and size of pipe being installed with an "O" ring seal cemented in place. All nuts, bolts, and pins shall be corrosion resistance bronze or stainless steel. The saddle tap shall be of the same nominal size of the connecting pipe and shall have an AWWA taper thread tap.

Service saddle shall be equal to Mueller H-13000 Series, Ford S70- Series, A.Y. McDonald 3801 or approved equal.

G. Corporation Stops: Brass corporation stops shall conform to AWWA C800 for ball type stops. The inlet shall have AWWA tapered thread compatible with the service saddle. The outlet shall be compression type for the service pipe being used. The corporation stop shall be designed to allow tapping of the main through the corporation stop with the main under pressure.

The corporation stops shall be equal to Mueller, Ford, A.Y. McDonald, or approved equal.

H. Service Line Coupling: Coupling for connection of water service pipe shall be brass with compression connection fitting.

The coupling shall be equal to Mueller, Ford, A.Y. McDonald, or approved equal.

I. Curb Stops: Brass curb stops shall be provided on the opposite side of a street from the saddle and corp stop. They shall conform to AWWA C800 and shall have PVC pipe size compression joints. The curb stops shall be a full flow ball type design equal to Mueller, Ford, A.Y. McDonald, or approved equal.

J. Locator Tape: A metal detectible tape shall be used to mark the water main location. The tape shall be 3" wide, 5 mil. thick with a solid aluminum foil core laminated between two 2 mil. film. The base color shall be blue with printing "CAUTION: WATER LINE BELOW" which is continuously repeated. The tape shall be equal to PRO-LINE Safety Products.

K. Pressure Regulator (Main Line): Where a main line pressure reducing station is noted the contractor shall install pressure reducing valves of the size noted on the plans. The pressure reducing valve shall have a pressure rating of 175 psi (max.), cast iron body and over ASTM A48. Main valve trim shall be bronze ASTM B61. Pilot control shall be cast bronze ASTM B62 with 303 stainless steel trim. Valve seat shall be a resilient, synthetic rubber disc and a single removable seat insert. The diaphragm shall be nylon fabric bonded with synthetic rubber. Packing glands or stuffing boxes shall not be used. All repairs shall be possible with removing the valve from the line. The pressure reducing valve shall automatically reduce a higher inlet press to a steady lower downstream pressure regardless of changing flow rates or varying inlet pressure. The valve shall be accurate, pilot-operated, single seated, diaphragm type globe valve. Pressure adjustment shall be by a single adjusting screw, with a protection housing and provisions for sealing. The total following spare equipment shall be provided: 1 pressure reducing control; 1 diaphragm; 1 disc for each valve size; 1 seat for each valve size; "O" rings, 1 gasket of each size used in valve.

L. Pressure Relief Valve: Where required by the plans a pressure relief valve shall be installed. The pressure relief valve shall be rated for 175 psi (max.), cast iron body and cover ASTM A48. Main valve trim shall be bronze ASTM B61. Pilot control shall be cast bronze ASTM B62 with 303 stainless steel trim. Valve seat shall be a resilient, synthetic rubber disc and a single removable seat insert. The diaphragm shall be nylon fabric bonded with synthetic rubber. Packing glands or stuffing boxes shall not be used. All repairs shall be possible without removing the valve from the line. The pressure relief valve shall be designed to maintain a maximum upstream pressure. The valve shall open when the pre-set pressure is exceeded. The valve shall be hydraulically operated, pilot-controlled, modulating type. The valve shall have quick opening, gradual closing. The total following spare equipment shall be provided: 1 diaphragm, 1 disc; and 1 seat for each valve size provided; "O" rings; 1 gasket of each size used in a valve.

M. Thrust Restraint: Where required on the plans, PVC pipe joint restraints shall be installed. Where mechanical joint fittings are present, high strength low alloy T-bolts and nuts in accordance with AWWA A21.11 shall be used in conjunction with two piece restraint devices which have machine serrations that grip the PVC pipe when clamped together. The restraint device shall be high strength ductile iron, ASTM A536, Grade 65-45-12.

Where a PVC bell exists, a backup ring shall be used to fit behind the pipe bell with T-bolts and the above described restraint device.

The two piece restraint device shall grip the pipe for a full 360° and be designed to not be over tightened. The device shall have a working pressure rating equal to the pipe pressure rating or a minimum of 200 psi. They shall meet or exceed the Uni-B-13-94 Recommended Performance Specification for Joint Restraint Devices for use with PVC pipe.

31. Water Detail Drawings:

A. The following attached drawings are made a part of this specification.

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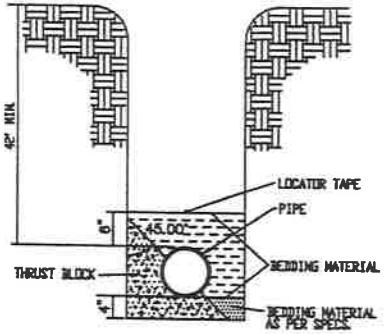
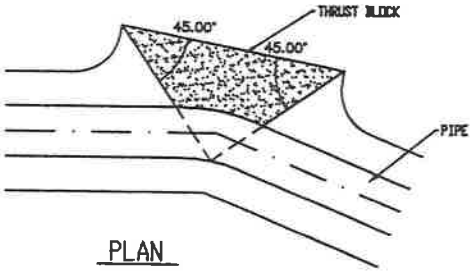


SECTION

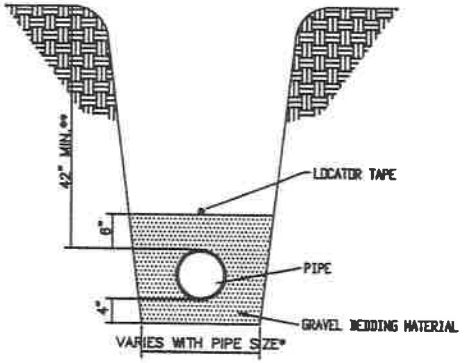


PLAN

THRUST BLOCKING DETAIL

BLOCK BEARING AREA

PIPE SIZE	22 1/2°	45°	90°	"Y" & VALVE OR PLUG
3"	0.5 SQ. FT.	0.5 SQ. FT.	0.9 SQ. FT.	0.65 SQ. FT.
4"	0.5 SQ. FT.	1.3 SQ. FT.	2.3 SQ. FT.	1.7 SQ. FT.
4"	1 SQ. FT.	2 SQ. FT.	4 SQ. FT.	3 SQ. FT.
6"	2 SQ. FT.	4 SQ. FT.	7 SQ. FT.	5 SQ. FT.
8"	4 SQ. FT.	8 SQ. FT.	12 SQ. FT.	9 SQ. FT.
10"	6 SQ. FT.	11 SQ. FT.	20 SQ. FT.	14 SQ. FT.



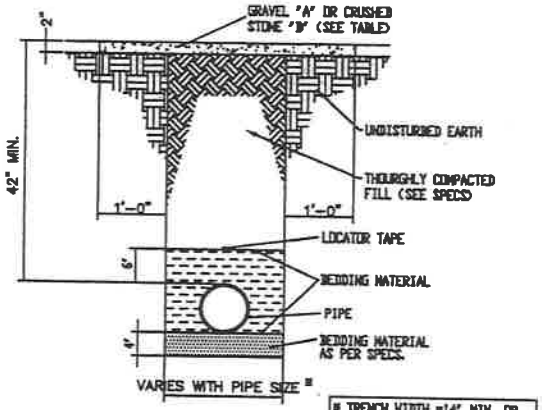
BEDDING FOR PIPE IN TRENCH

* TRENCH WIDTH =14" MIN. OR PIPE DIA. PLUS 8"

** IN SOLID ROCK, 30" COVER MAY BE USED.

PIPE BEDDING MATERIAL

	PERCENT
PASSING 38"-SIEVE	100
PASSING NO. 4 SIEVE	95-100

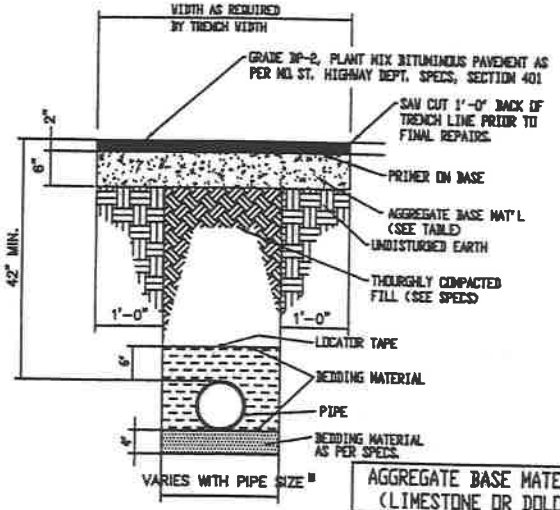


* TRENCH WIDTH =14" MIN. OR PIPE DIA. PLUS 8"

AGGREGATE SURFACING MATERIAL

GRADE	KIND OF MAT'L	PERCENT PASSING BY WEIGHT SIEVE SIZE					
		1"	3/4"	3/8"	NO. 4	NO. 10	NO. 200
A	GRAVEL	100	80-100	—	<60	10-35	0-10
B	CRUSHED STONE	100	—	<65	—	5-25	—

NOTE: "<" INDICATES MAXIMUM PERMITTED

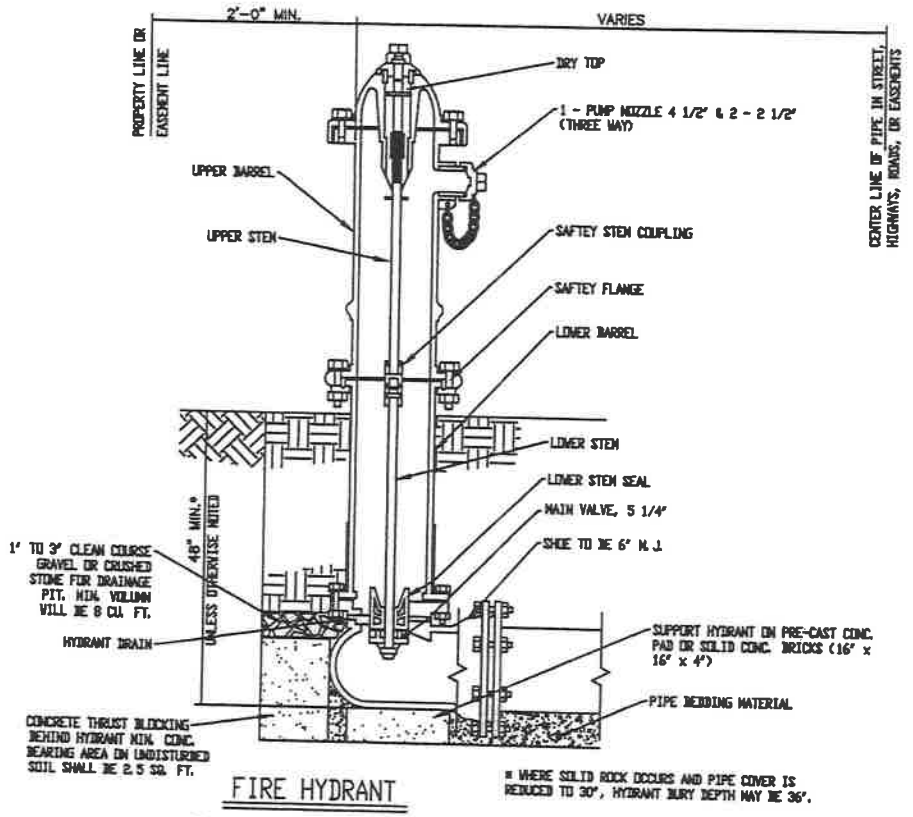


AGGREGATE BASE MATERIAL (LIMESTONE OR DOLOMITE)

	PERCENT
PASSING 1"-SIEVE	100
PASSING 1/2"-SIEVE	60-90
PASSING NO. 4 SIEVE	40-60
PASSING NO. 40 SIEVE	15-35

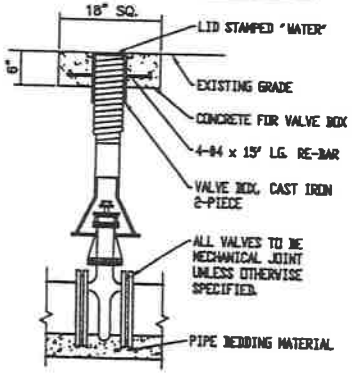
SURFACE REPLACEMENT FOR WATER LINES UNDER ROADWAYS

WATER SYSTEM DETAILS

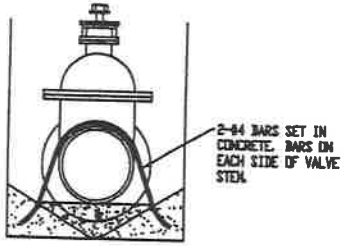


* WHERE SOLID ROCK OCCURS AND PIPE COVER IS REDUCED TO 30", HYDRANT BURY DEPTH MAY BE 36".

FIRE HYDRANT

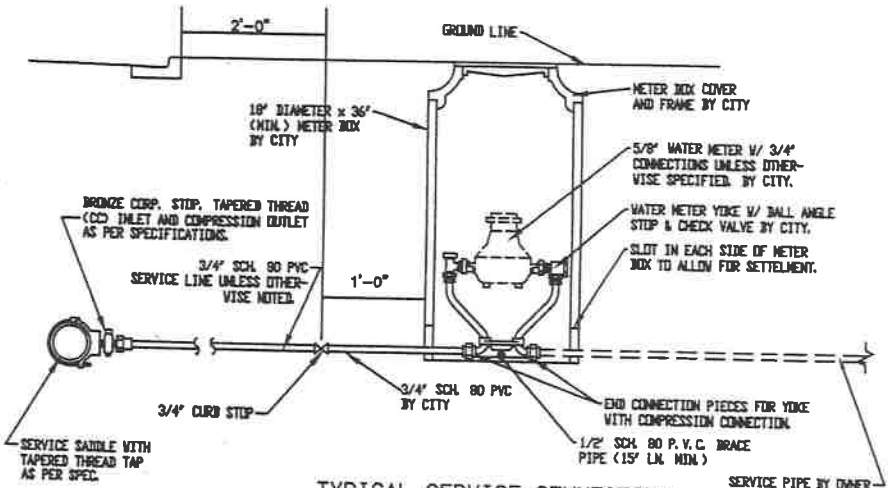


GATE VALVE & BOX



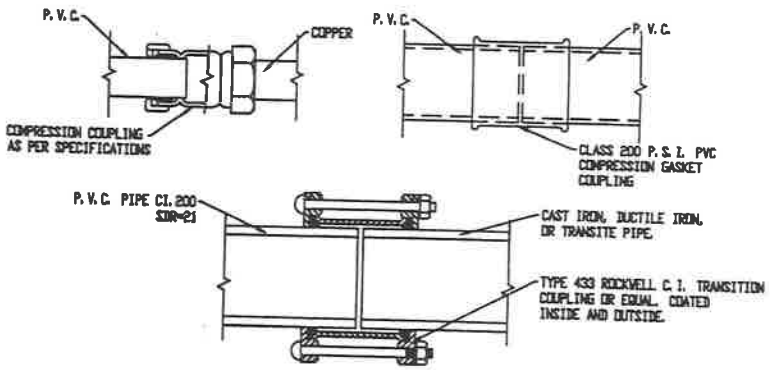
NOTE: ALL 4" VALVES AND LARGER ARE TO BE ANCHORED.

ANCHOR FOR GATE VALVE



TYPICAL SERVICE CONNECTION

(WHERE MAIN IS ON THE OPPOSITE SIDE OF STREET FROM LOT TO BE SERVED.)



TRANSITION COUPLING DETAILS

WATER SYSTEM DETAILS

SECTION VIII

SANITARY SEWER SYSTEM

SPECIFICATION

1. Definition
2. Classification of Excavation
3. Lines and Grades
4. Sheeting, Timbering or Bracing
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6. Leaks or Springs
7. Backfilling
8. Laying Pipe
9. Cement
10. Concrete
11. Cement Mortar
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13. Water
14. Forms
15. Manholes
16. Drops into Manholes
17. Lampholes
18. Paving
19. Expansion Joints
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22. Reinforcing Steel
23. Manhole and Lamphole Castings
24. Pipe Joint Material
25. Bedding Material
26. Miscellaneous Materials
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29. Grading and Seeding
30. Fences and Gates
31. Field Tests
32. Sewer Detail Drawings

SANITARY SEWER SYSTEM

SPECIFICATIONS

1. DEFINITIONS:

The term "City" shall mean the City of Forsyth, Missouri, and their designated official.

The term "Engineer" shall mean the design engineer, and his seal shall be that of an officially registered professional engineer with the State of Missouri.

2. CLASSIFICATION OF EXCAVATION:

a. Earth Excavation: All excavation not classified as rock excavation shall be classified as earth excavation.

b. Solid Rock Excavation: Rock excavation is herein defined as such material as cannot be excavated without drilling and blasting, sledging or barring. All stone boulders less than 10 cubic feet in volume will be classified as "earth" and all larger boulders shall be classified as rock.

Wherever rock is encountered in trench or elsewhere, and where excavation is required to be made, the contractor shall excavate the same.

3. LINES AND GRADES:

a. The contractor shall build to the lines and grades as shown on the plans. Alignment and elevation control offset grade stakes and hubs shall be provided at each manhole location. The contractor shall be held responsible for all variation of lines and grades, as established and laid out on the plans. The City may check the pipe at any given point before the trench has been backfilled, and if there is a variation of more than two hundredths (0.02) of a foot, from the true grade, the same shall be raised, or lowered, as the case may be, unless the Engineer approves the grade change.

b. The use of laser aligning equipment is required for the laying of sewer lines to the specified lines and grades. All units must have equipment to control atmospheric conditions in the pipe that could effect the acceptable standard of construction including fans and blowers to remove excessive heat or fumes.

The laser aligning method selected must be shown to have worked satisfactorily on prior contracts, and is operated by competent trained men. These operators will be required to show that they have a working knowledge of the manufacturer's recommendations for proper operation of the laser. The equipment used shall be approved by the Engineer. The Engineer will establish center line by the design plans.

c. All excavation shall be made with a sufficient working space to permit the placing, inspection and completion of all work contemplated in the contract. Excavated material that is unsuitable and all boulders exposed by grading shall be removed from the work. The top 12" layer of soil shall be kept separate and shall form a final surfacing of all backfill, except for gravel or hard surface paved areas.

d. Excavation shall in all cases be continuous from surface to bottom line of the trench. Material excavated shall be laid compactly on the sides of the trench, and kept trimmed up so as to be of little inconvenience as possible to the traveling public and adjoining tenants.

e. The excavation shall not be performed any farther ahead of the bedding and pipe laying than is necessary to permit a continuous operation.

f. Contractor shall conduct the work at all time so as to cause no more obstruction or inconvenience to the public than is deemed necessary by the owner. Free passage for vehicles and pedestrians shall be maintained along roadways, sidewalks, and drives, by bridging, if necessary, where it is practical to do so. Where bridging is unnecessary in the opinion of the City, the contractor may arrange for the diversion of traffic as hereinafter provided. Free access shall be provided to all fire hydrants, water and gas valves, and fire alarm or police call boxes.

When it becomes necessary to close any street, the contractor shall notify the City at least 48 hours in advance of such closure including information as to the exact location and extent, the time and expected duration and the reason for the closure. If, in case of an emergency, it becomes necessary to close any street without advance notice, the contractor shall immediately notify the Police and Fire Departments and advise the City of such closure at the earliest opportunity.

The Contractor shall provide for sufficient number of warning lights, signs, and barricades to be available on the work and shall cause them to be placed in such numbers and at such locations as required to maintain reasonable safety to pedestrians and vehicular traffic. When it becomes necessary to divert traffic, a detour route shall be selected by the City and the contractor shall place directional signs of such nature and in sufficient numbers to clearly define the detour route. Barricades, lights and warning signs shall be constructed in accordance with Section 20 of the Manual of Accident Prevention in Construction published by the Associated General Contractors of America or as otherwise approved by the owner. Warning lights shall be lighted from sunset to sunrise.

g. The contractor is solely responsible for all safety issues. The contractor shall comply with all federal, state, and local regulations pertaining to safety

4. SHEETING, TIMBERING OR BRACING:

Sheeting, timbering or bracing or other similar protection shall be placed by the contractor wherever necessary for the proper preserving of any excavation, embankment or structure. Where the material is of such character or other conditions are such as to render it necessary, the protective methods used shall be designed by the contractor and installed by the contractor to brace the trench and protect workers, equipment, finished products and adjacent structures, etc. The contractor shall be held responsible for the sufficiency of all sheeting and bracing or other means of protection used,

and for all persons injured or property damaged as the result of improper quality, strength, pacing, maintaining or removing the same. The contractor shall comply with all federal and state laws and regulations to afford a safe working condition.

The contractor shall, at his own expense, shore up, protect and insure from injury all building, retaining walls, viaduct piers, and footings, storm sewers, sanitary sewers, gas lines, water lines, fences, curbs, trees, poles or other property liable to the injured during the progress of the work, and he will be held responsible for all damage which may occur by reason or prosecution of the work.

5. REMOVAL OF WATER:

The contractor shall furnish and operate sufficient pumps and appliances, and shall provide all materials, labor, etc., required to prevent interferences with any work by water, ice or snow. Damage of any kind resulting from insufficient pumping facilities or similar lack of proper conduct of the work shall be made good by the contractor at his own expense. No structure or pipe shall be laid in water and no water shall be allowed to run into or over any concrete work or pipe, or into or through any pipe.

6. LEAKS OR SPRINGS:

When leaks or springs are found which, in the opinion of the Engineer or City, affect the safety or usefulness or satisfactory operation of any of the permanent work, he may direct special provisions to be taken.

7. BACKFILLING:

a. Material used for backfilling shall be free from perishable matter and from other material liable to become unstable when saturated with water after having been compacted. No frozen material shall be used in the backfill. Care shall be taken to avoid injury to structures, pipes, etc. or producing unequal pressure thereon. Special precaution shall be taken backfilling over pipes. No backfill shall be placed over any portion of pipes not inspected by the Engineer and City.

b. Initial backfill for ductile iron gravity sewer pipe shall be completed in accordance with ANSI A21.50 (AWWA C150). Bedding material shall be used and considered equal to Type 4. The bedding shall have a minimum thickness beneath the pipe of 4" or 1/8 of the outside diameter of the pipe, whichever is greater. Backfilling around and 6" above the pipe shall be free from rocks greater than 2" in diameter.

c. Initial backfill for PVC solid wall pipe shall be in accordance with ASTM D2321, latest revision, for installing flexible thermo-plastic sewer pipe. Bedding material shall be used and considered equal to Class I. The bedding shall have a minimum thickness beneath the pipe of 4" and shall extend up and to 6" over the top of the pipe.

d. Tamping over and near the pipe must be carefully done to prevent injury to the pipe. Backfilling for the remainder of the trench shall contain no stone over six inches in its largest dimension. This backfilling shall be deposited and spread in layers and solidly tamped. As the trenches are backfilled, the contractor shall remove all surplus material and regrade the surface, leaving all right-of-way and streets clear and in good order.

e. The trenches must be filled to the height which previously existed.

f. Trenches under streets or other traffic areas shall be backfilled with crushed rock bedding material for the entire trench depth. Minimum compaction shall be 95% of maximum. Backfill of excavated materials shall be a minimum of 90% maximum.

g. Over excavation of the trench shall be backfilled with bedding material to the proper pipe elevations.

h. The trench width at the top of the pipe should be kept as narrow as possible.

i. Any settlement of the backfill below the original ground surface shall be remedied by the contractor for a period of 12 months after final completion and acceptance, including re-seeding, mulching and pavement repairs.

SEWER CONSTRUCTION

8. LAYING PIPE:

a. Pipe shall be laid with a laser beam target.

b. The alignment of all pipe lines between adjacent manholes shall be true to line and grade; the pipe line from manhole to manhole shall reflect the full bore of the pipe. The pipe shall be truly centered into the abutting pipe.

c. "Tee" or "Wye" branches for building sewer lines shall be installed at locations shown on the plans, or as the Engineer may direct; they shall be 4" in diameter unless otherwise specified by the Engineer and shall be closed with covers anchored in place by methods recommended by the manufacturer and approved by the Engineer. Saddle type Tee or Wye shall not be used for new construction.

d. The exact location of all "Tee" or "Wye" branches and other special pieces shall be carefully ascertained by the contractor or Engineer, before concealment by backfilling, by accurate measurement from the center of the manhole next below in the same line of pipe; that a true and exact record may be preserved for future use. No "Tee" or "Wye" branch or special pieces shall be covered before its exact location has been noted and recorded. As-built drawings shall be provided by the Engineer and they shall reflect the Tee and Wye locations along with any other plan changes.

e. The grade lines shown on the profile drawings is the bottom of the inside of the sewers. The pipes and specials shall be truly laid to line and grade throughout; and all junctions, curves, branches, and other required fittings shall be properly excavated for and laid as shown on the plans and drawings, and as directed by the Engineer. Each pipe shall be laid in an even firm bed, so that no uneven strain will come to any part of the pipe. Particular care shall be exercised to prevent the pipe from bearing on unstable, uneven bedding. Installation shall conform to the manufacturer's recommended means and methods and the contractor shall be solely responsible for the installation.

f. The interior of the sewer shall be cleaned of all dirt, jointing materials, and superfluous material of every description. Any open end of the line shall be securely closed at the end of each day's work to prevent the entrance of water, small animals, trash or any other obstructions and shall not be opened until work is resumed.

9. CEMENT:

a. Cement shall be standard brand of Portland Cement and shall meet the requirements of the ASTM, Serial Designation C150, Type I, Specifications with all subsequent revisions.

10. CONCRETE:

a. The proportions of water, cement and aggregates shall be such that the mixing water, including the free surface moisture of the aggregate, shall not exceed 6 gals/sack of cement. The cement content shall not be less than 5.75 sacks/cu. yd. of mixed concrete. All concrete shall conform to requirements of the ASTM Serial Designation C94 for ready-mixed concrete and any subsequent revisions.

11. CEMENT MORTAR:

a. All cement mortar required shall have the same sand-cement ratio as used in concrete and sufficient water to give the required consistency. Only sufficient mortar shall be mixed to take care of the work at hand. No mortar that has begun to set will be permitted to be used. No retampered mortar shall be used.

b. Non-shrink grout equal to Embeco shall be used where specified on the plans.

12. AGGREGATES:

a. Fine aggregate shall consist of river sand which shall be free from alkali and surface coatings and shall not contain injurious amounts of organic or other injurious matter. Aggregate shall conform to requirements of ASTM C33.

b. Coarse aggregate shall consist of crushed limestone free from dust, flint, mud balls or other foreign matter. Aggregate shall conform to requirements of ASTM C33.

13. WATER:

a. The water used for mortar, concrete, or any other construction purpose shall be free from oil, acid, strong alkali or organic material.

14. FORMS:

a. All forms (metal or wood) shall be watertight, smooth (if wood, lumber shall be dressed on all sides), and shall be securely fastened by nails, screws, or bolts. They shall be thoroughly and securely braced to keep them in exact positions and alignment during the placing and setting of the concrete. The forms shall be coated with an approved oil to prevent adherence of concrete.

15. MANHOLES:

a. Precast concrete manholes shall be used and shall conform to the dimensions and details as shown on detail plans and meeting ASTM C478 specifications. Manhole section joints shall be sealed with Ram-Nek, Kent Seal #2, or equal, to obtain a pliable watertight joint. Installation shall conform to the manufacturer's recommendations.

b. A certification of compliance shall be provided for the manholes, manhole steps and manhole frame and cover. This certification shall be submitted as a shop drawing to the Engineer with the Engineer providing the City with an approved copy.

c. The concrete base and invert shall be constructed as shown on plans. Care shall be taken to obtain a proper bond between the base, invert, and manhole section. All leaks shall be repaired. Manhole bases and inverts shall be vibrated. Manhole barrel sections shall be waterproofed on the exterior using Koppers Bitumastic Super Service Black, Ram-Nek Primer I, or equal.

d. Manhole steps shall conform to ASTM C478, latest revision and shall be spaced as shown on the plans. Steps may be cast iron, or copolymer polypropylene plastic which encases a 1/2" grade 60 steel reinforcing bar, or low density polyethylene which encases a 3/4" diameter 6351-T6 aluminum extrusion.

e. Precast manhole bases and inverts may be used. Precast bases shall have four #4 rebars embedded in the manhole section plus wire mesh. Precast bases shall be placed on a 6" crushed stone base over an undisturbed earth, set to the correct elevation prior to making final pipe connections. In unstable soil conditions a concrete pad will be required to prevent manhole settlement. Precast inverts may be used.

f. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection equal to A-Lok that allows differential settlement of the pipe and manhole wall to take place. The gasket shall be cast into the manhole bottom section and conform to tests of ASTM C425. The invert shall not prevent the pipe at the gasket and manhole wall from moving vertically or horizontally.

g. Where existing manholes are tied into, the contractor shall core the wall or drill a series of holes and break through the wall to allow for the new pipe entry. A flexible watertight gasket shall be installed and grouted in place with non-shrink grout.

16. DROPS INTO MANHOLES:

a. All drops into the manhole where shown on the plans shall be constructed of the same size pipe as the sewer and shall conform to the detailed plans.

17. LAMPHOLES:

a. Lampholes shall conform to the detailed plans and shall be constructed with 8" pipe.

18. PAVING:

All paving which must be removed during the course of construction or which, in the opinion of the City, has been damaged during the progress of the work, shall be replaced with the same type of material as the original paving or, as otherwise specified in the Specifications or detailed plans.

a. Backfilling for pavement repairs: The trench shall be backfilled with crushed rock bedding and shall be backfilled level with the existing riding surface of the roadway with 8" thickness of aggregate base rock. When the excavation has been properly backfilled and has settled sufficiently to permit the final repairs, the backfill shall be removed to a depth necessary to complete the pavement replacement. The existing paving shall be removed for a distance of 12" on each side of the original excavation. The paving shall be sawed then broken with care so as to insure a straight edge and a uniform patch. Where a full width repair is required, the base rock shall be brought even to the surrounding paving.

b. Where pavement replacement is required, it shall be in conformance with that shown on the detail plans and contained in these specifications.

c. The contractor shall be responsible for maintenance of the pavement and the repairs.

19. EXPANSION JOINTS:

a. All expansion joint fillers shall consist of suitable bituminous material that will not become soft enough to flow in hot weather nor brittle in cold weather; reinforced on each side with a layer of high grade saturated felt, and furnished in prepared strips and shall be of the size indicated on the plans, or as specified by the Engineer.

20. BLASTING:

a. The contractor shall conform to the Federal, State and Municipal laws in the handling, transportation and use of explosives. Where blasting is necessary, suitable weighted plank covering or mattresses shall be provided to confine all materials lifted by the blasting, within the limits of the trench or other excavation and to prevent injury to life and property. All excavated rock which cannot be shoveled as earth shall be kept separately from other excavated materials and shall not be mixed with other backfill material.

b. Where blasting is anticipated, the contractor shall obtain proper liability insurance coverage for blasting operations, conduct a pre-blast survey of all potential affected structures, and monitor the blast by recording seismograph that notes the magnitude of ground movement.

c. The contractor shall be liable for all damages resulting from any blasting operaton.

21. PIPE:

a. Sewer pipe may be ductile iron or polyvinyl chloride (PVC), except that ductile iron must be used where called for on plans.

b. Ductile iron pipe shall meet ANSI 21.51 (AWWA C151) pressure Class 350 (min) with cement mortar lining conforming to ANSI 21.4 (AWWA C104) and bituminous seal coat.

c. Polyvinyl chloride (PVC) sewer pipe shall be SDR-26 conforming to ASTM D-3034, cell classification 12454B. The pipe shall have integral wall bell and spigot joints with flexible, mechanically locked in place compression type gaskets conforming to ASTM D-3212 and ASTM F-477.

d. PVC pipe fittings shall be SDR-26 conforming to ASTM D-3034, cell classification 12454 B, with elastomeric gasketed joints conforming to ASTM D-3212 and ASTM F-477.

e. A certification of compliance with the specification for pipe and joint materials shall be provided. This certification shall be submitted as a shop drawing to the Engineer with the Engineer providing the City with an approved copy.

22. REINFORCEMENT STEEL:

a. Reinforcement steel shall conform to the requirements of the Standard Spec. for Billet-Steel concrete Reinforcing Bar, intermediate grade. When placed, all bars shall be free from mill scale, rust pits, or flakes and dirt.

23. MANHOLES AND LAMPHOLE CASTINGS:

a. The cast iron manhole and lamphole covers shall conform in dimension to the detailed plans hereto attached. Castings shall conform to the requirements of ASTM A48-74, Class 30 minimum. A certification by the manufacturer shall be submitted as a shop drawing to the Engineer with the Engineer providing the City with an approved copy.

b. Manhole castings shall have machined surfaces, be traffic rated, weigh a minimum of 400 lbs., have an entry opening of at least 22" diameter, use a single pick hole and have centering lugs or a mud ring. Bolt down, gasket lids, may be required where water may pond over the manhole.

24. PIPE JOINT MATERIAL:

a. The joint material for ductile iron pipe shall conform to ANSI 21.11 (AWWA C111) latest revision or as noted on the plans.

b. The joint for solid wall PVC pipe shall be an elastomeric gasketed joint with assembly of joints conforming to manufacturer's recommendations, and ASTM C3034.

25. BEDDING MATERIAL:

a. Material for bedding shall be crushed limestone or washed and crushed gravel conforming to the following gradation requirements of ASTM C33, Size 67.

Passing	1" sieve	100%
Passing	3/4" sieve	90 to 100%
Passing	3/8" sieve	20 to 55%
Passing	No. 4 sieve	0 to 10%
Passing	No. 8 sieve	0 to 5%

26. MISCELLANEOUS MATERIALS:

a. Any materials found necessary to use during construction but not described in this specification shall be subject to the approval or rejection by the City.

27. HIGHWAY CROSSINGS:

The contractor shall make highway crossings where shown on the plans. The contractor shall pay fees and obtain permits for the crossings and shall comply with all requirements of the Highway Department. If the Highway Department requires that the line be tunneled or bored through, the contractor shall furnish all pipe, pipe encasement, tunneling or boring equipment, timbering, shoring, bracing, rock excavation and other labor and materials required.

a. Casing Pipe: Casing pipe and joints shall be constructed from new steel, having a minimum yield strength of 35,000 psi. Joints shall be leakproof by welding.

(1) Pipes under highway crossings shall have the following wall thickness: 16" and under 0.188"; 18", 20" and 22" 0.25".

b. Casing Pipe Installation: Casing pipe shall be jacked or installed in an auger-bored hole to the line and grade required by the plans. Voids 2" larger in diameter than the casing shall be filled with cement grout or sand.

c. Carrier Pipe Installation: The carrier pipe shall be placed in the casing and supported as required to obtain the proper line and grade using temporary wood shims and then the entire casing filled with sand for permanent support. Neat cement plugs shall be placed at the ends of the casing. Concrete cradle shall be placed with the pipe where it enters and leaves the casing. Bore pits shall be backfilled with crushed rock up to the bottom of the pipe to provide a firm support and prevent settlement and damage to the pipe.

28. DESIGN STANDARDS FOR LOCATION OF SEWERS WITH RESPECT TO WATER MAINS:

a. Horizontal Separation: Whenever possible, sewers, should be laid at least 10 feet, horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if;

(1) It is laid in a separate trench, or if

(2) It is laid in the same trench with the water mains located at one side on a bench of undisturbed earth, and if

(3) In either case the elevation of the top (crown) of the sewer is at least 18" below the bottom (invert) of the water main.

b. Vertical Separation: Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18" below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical joint type pipe for a distance of 10 feet on each side of the sewer so that both joints will be as far from the sewer as possible.

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both the water main and sewer should be constructed of mechanical joint cast-iron and shall be pressure-tested to assure watertightness.

c. Water Supply Interconnections: There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable supply.

29. GRADING AND SEEDING:

a. All disturbed lawn, pastures, and other non-paved grass areas shall be graded and seeded as follows:

After the trench backfill has been compacted, the excavated area shall be covered with the stockpile top soil at least 2" deep and free of rock larger than 1" in largest dimension and noxious weeds or seeds. Before final raking, areas to be seeded shall be fertilized with a mixture containing 12 lbs. each of soluble nitrogen, phosphoric acid and potash per 100 lbs. by spreading evenly at the rate of 12 lbs. per 1,000 sq. ft. of area using a mechanical spreader of the rotary type. Lime shall be added at a minimum rate of 1,000 lbs./acre or to a soil pH of 6.0. The area shall then be raked to a smooth even surface, the soil loosened to a depth of at least 1" and seeded.

The seed mixture shall be the type of grass that exists in that location. In those areas where the variety of grass cannot be determined, the seed mixture for maintained lawn areas shall be as follows and shall be evenly distributed over the area at the rate of 6-8 pounds per 1000 square feet using a mechanical seeder. No seed or mulch shall be placed until the engineer accepts the grade and seedbed.

Variety	Mixture	Purity	Germination
Turf Type Tall Fescue	100%	95%	90%

The following seed mixture shall be used in all other areas such as fields, pastures, roadside ditches, etc. where the existing variety cannot be determined, and shall be evenly distributed over the area at the rate of 33 pounds per acre (1 pound per 1000 square feet) using a mechanical seeder.

Variety	Mixture	Purity	Germination
Kentucky 31 Fescue	90%	95%	90%
Annual Rye Grass	10%	98%	90%

All seed shall be free from Johnson grass, Canadian thistle or field bindweed seed and contain less than 2% of other weed seed, and shall be from the previous years seed crop.

All reseeded areas shall receive straw mulch at a rate not less than 2-1/2 ton per acre (100 pounds per 1000 square feet).

Reseeding of disturbed areas shall be accomplished as the construction work progresses, during the next available Spring or Fall seeding period. Unless authorized by the Engineer, no seeding shall take place from November 1 through April 1 and from June 1 through August 15.

The contractor shall guarantee a stand of grass and shall protect all landscaping work against damage until completion and final acceptance of the work.

30. FENCES AND GATES:

a. Before proceeding with construction operations, contractor shall furnish and install suitable, substantial gate or gap in every fence at intersection with right of way for access to land crossed by pipeline and for passage of construction equipment. Fences shall be reinforced as necessary to prevent damage. Where fences are encountered, they must not be cut unless contractor obtains written consent of Owner and tenant and adequate arrangements are made for bracing and rebuilding. Contractor will replace fences to their original location and conditions upon completion of the line segment. Fences which are cut shall be repaired using compression sleeves which are crimped to splice the fence using materials designed for the specific repair.

b. Contractor shall be responsible for keeping gates closed at all times during performance of work, shall prevent livestock from entering or leaving properties, and shall furnish watchmen or temporary fencing, if necessary, at contractor's expense to enforce compliance with this instruction. Contractor shall be responsible for any damage to or caused by livestock entering or leaving property through open gate or slack fence caused by improperly installed gate.

c. The contractor shall provide adequate temporary fencing and gates as necessary to prevent livestock from the construction area. Such temporary fencing shall remain in place until all excavations are backfilled. The contractor shall be responsible for all damage or injuries due to soft soils, trench settlement or lack of trench compaction to livestock or farm equipment and personnel.

31. FIELD TESTS:

a. The contractor shall furnish the owner with every reasonable facility for ascertaining whether or not the work performed was in accordance with the requirements and intent of the plans and specifications. Any work done (except excavation) or material used without suitable supervision or inspection by the Engineer may be ordered removed and replaced at the Contractor's expense.

b. After the completion of the work the contractor shall, under the direction of the Engineer, make such tests of the entire work or any part thereof as may be required to demonstrate the efficiency of the sewer and appurtenances. If required, the contractor shall make such openings as the Engineer may direct and shall restore the part of the work so disturbed to the satisfaction of the Engineer. Should any of the work be found faulty in any respect, the contractor shall repair such effects or replace them with new work as may be directed by the Engineer.

c. The contractor shall provide facilities to the Engineer to make a visual observation test of the straightness of each section of sewer between two adjacent manholes. The Engineer shall obtain a full bore vision of the entire pipe line from one manhole to the next. There shall be no visible leakage or damage in the system including manholes and lines. All such leaks or damage shall be corrected.

d. If the ground water table is 2 foot or more above the top of the sewer line the contractor shall perform an infiltration test, under the direction of the Engineer on all such lengths of pipe. The testing shall be carried out by the installation of a plug with a pipe extension through the plug to catch the flow in a graduated container for measurements at such locations as determined by the Engineer and in his presence. Infiltration shall not exceed 100 gallons per inch of diameter per mile of pipe per day per manhole reach. A suitable plug shall be installed where required to determine accurate infiltration rates.

e. If the groundwater table is less than 2 foot above the top of the sewer line the contractor shall have the option under the direction of the Engineer, to perform an exfiltration test or a low pressure air test on all such reaches of pipe. The contractor shall provide for water and all equipment necessary to make such tests. If the contractor elects to perform low pressure air testing, the contractor may be required to verify the accuracy of the air testing by performing an exfiltration test on a representative section of line. The tests shall be performed in either the following manners.

(1) Exfiltration Test:

A section of sewer line shall be prepared for testing by plugging the upper side of the downstream manhole and all openings in the next upstream manhole except the downstream opening. Where grades are slight, two or more sections between

manholes may be hydrostatically tested at once. Where grades are steep, the maximum head on any section under test will not exceed ten (10) feet. Branch building sewers running from Y-branches on the mains shall be plugged at their upper end and included in the test.

A section of sewer line prepared as above shall be tested by filling with water to an elevation of 4 feet above the invert at the midpoint of the test section, or 4 feet above the existing ground water elevation or 1 foot above the top of the pipe in the upstream manhole, whichever is greater. The water should be introduced into the test section at least 4 hours in advance of the official test period to allow the pipe and joint material to become saturated with water. All entrapped air is to be removed from the test section prior to performing the test. At the beginning of the test the elevation of the water in the upper manhole shall be carefully measured from a point on the manhole rim. After a period of one hour, or less, with the approval of the Engineer, the water elevation shall be measured from the same point on the manhole rim and the loss of water during the test period calculated. If directed by the Engineer, enough water shall be precisely measured into the upper manhole to restore the water to the level existing at the beginning of the test and the amount added shall be used to determine leakage.

Should an initial test show excess leakage in a section of line, it is permissible to draw the water off and test the manhole that contained water. This test shall be made by plugging all the openings in the manhole and filling with water to the same elevation as existed during the test. The leakage from the manhole may be deducted from the total leakage of test section in arriving at the test leakage. If it is necessary or desirable to increase the test head above 4 feet, the allowable leakage will be increased to allow for the increase in head. Sewer sections showing leakage in excess of that allowed shall be repaired or reconstructed as necessary to reduce the leakage to that specified.

The maximum allowable exfiltration for this test shall be 100 gal/inch of pipe diameter/mile/day.

(2) Low Pressure Air Test:

At the contractor's option all newly laid pipe shall be subjected to a low pressure air test after backfilling and before replacing pavement in lieu of an ex-filtration test. The equipment shall be provided and test shall be conducted by the contractor in the presence of the Engineer. The test shall be in accordance with ASTM F1417-92.

All stubs, wyes, tees, and branch building sewers shall be included in the test end shall be suitably capped and braced to withstand the internal pressure during testing. Such caps shall be easily removable for future connections or extensions.

Air for pressurizing of the test section shall be supplied by a properly calibrated portable, oil-free air source with a singular control panel containing a main shut-off valve, pressure-regulating valve, 9 psig pressure-relief valve, input pressure gauge, a continuous monitoring pressure gauge having a pressure range of 0 psi to at least 10 psi with minimum divisions of 0.10 psi and an accuracy of $\pm$ 0.04 psi, and a rotometer with standard CFM reading and an accuracy of $\pm$ 2% .

There shall be three hose connections from the control panel to a triple connection plug inserted in one end of the test section. One hose shall be used only for inflation of the pneumatic plug to isolate the test section. The second hose shall be used for continuously reading the air pressure rise in the test section. The third hose shall be used only for introducing low pressure air into the test section.

Low pressure air shall be introduced into the test section until the internal air pressure reaches 4.0 psig. After the pressure reaches 4.0 psig, the air supply shall be regulated so that the pressure is maintained between 3.5 to 4.0 psig for at least 2 minutes to allow the pressure in the test section to stabilize. After the stabilization period, the air supply shall be disconnected and the pressure decreased to 3.5 psig before starting the test period.

The line section being tested shall not be accepted unless the time required for a 1.0 psig pressure drop from a starting pressure of 3.5 psig to a final pressure of 2.5 psig, using an allowable leakage rate of 0.0015 cubic feet per minute per square foot of internal pipe surface is greater than the time calculated by the following formula or shown in accompanying table:

$T = 0.085\ DK/Q$

where:

T = shortest time allowed for the air pressure to drop 1 psig in seconds,
K = 0.000419 DL but not less than 1.0,
Q = leakage rate in cubic feet/minute/square feet of internal pipe surface = 0.0015 CFM/SF,
D = measured average inside diameter of sewer pipe in inches, and
L = length of test section in feet.

Minimum Required Test Times by Pipe Size and Length

Pipe Diameter in.	Minimum Time Min & Sec.	Length for Minimum Time Ft.	Time for Longer Length Sec.	Minimum Time for Length (L) Shown in Min. & Sec.			
				100 ft.	200 ft.	300 ft.	400 ft.
4"	3:46	597	0.360L	3:46	3:46	3:46	3:46
6"	5:40	398	0.854L	5:40	5:40	5:40	5:42
8"	7:34	298	1.520L	7:34	7:34	7:36	10:08
10"	9:26	239	2.374L	9:28	9:26	11:52	15:49
12"	10:20	199	3.418L	11:20	11:24	17:05	22:47
15"	14:10	159	5.342L	14:10	17:48	28:42	35:36
18"	17:00	133	7.692L	17:00	25:38	38:27	51:16
21"	19:50	114	10.470L	19:50	34:54	52:21	69:48
24"	22:40	99	13.674L	22.47	45:34	68:22	91:10

The total allowable leakage from any test section shall not exceed 625 Q.

If the pressure drops 1.0 psig before the appropriate time shown in the above table or calculated from the formula has elapsed, the air loss shall be considered excessive and the test section has failed the test. If the test section fails the test, the contractor shall determine, at his own expenses, the source of leakage. Segmented testing may be utilized solely to find the location of leaks. Once leaks are located and repaired, the entire test section shall be retested in accordance with the above procedures.

The length of building sewer lines included in the test section may be ignored for determining required test time provided the minimum test time requirements are met. However, if the test section fails, time shall be recomputed to include all building sewer lengths using the following formula:

$$T = 0.085[D^2_1L_1 + D^2_2L_2 + \ldots + D^2_nL_n/D_1L_1 + D_2L_2 + \ldots + D_nL_n]K/Q$$

where:

T= shortest time allowed for the air pressure to drop 1.0 psig in seconds,
K= 0.000419 ($D_1L_1 + D_2L_2 + \ldots + D_nL_n$) but not less than 1.0,
Q = 0.0015 CFM/SF
D_1, D_2, etc. = nominal diameter of the different pipe sizes being tested in inches, and
L_1,L_2, etc. = respective lengths of the different pipe sizes being tested in feet.

If the recomputed test time is short enough to allow the test section to pass, then the test section meets the requirements of this test method and will be accepted.

Equipment for low pressure air testing of sewers may be secured from Cherne Industries, Inc., Hopkins, Minnesota or NB Products, New Britain, PA.

f. Each manhole shall be tested by use of a vacuum manhole tester by Cherne or equal. Testing shall include all manhole joints including frame to manhole joint. A vacuum of 10" Hg. or 5 psig shall be applied to each manhole. Loss of vacuum shall not exceed 1" Hg. over one minute. Test shall be conducted prior to backfilling manhole to aid in repairs. After manhole backfill has been placed, up to 10% of the manholes may be water exfiltration tested at the Engineer's discretion.

g. The contractors attention is directed to the fact that the stipulation of the maximum allowable field tests shall in no way relieve him of his obligation to correct, stop or otherwise remedy individual leaks in the system due to defective workmanship or material even though such leakage might come within the allowable maximum.

h. Test for Deflection:

When PVC pipe is used, a deflection test shall be made on the entire length of the installed pipeline on completion of all work including compacted backfill and placement of fill material over sewer lines. After pipe is installed and backfill is compacted, the contractor shall allow a minimum of 30 days before making the deflection test.

Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. The bell, cylinder or circular sections shall have a minimum diameter of 95% of the normal inside diameter of the pipe. Failure of the ball, cylinder, or circular sections to pass freely through a pipe run between manholes, either by being pulled through or by being flushed through with water, shall be justification for rejection at the expense of the contractor. Mechanical assisted pulling will not be allowed.

32. SEWER DETAIL DRAWINGS:

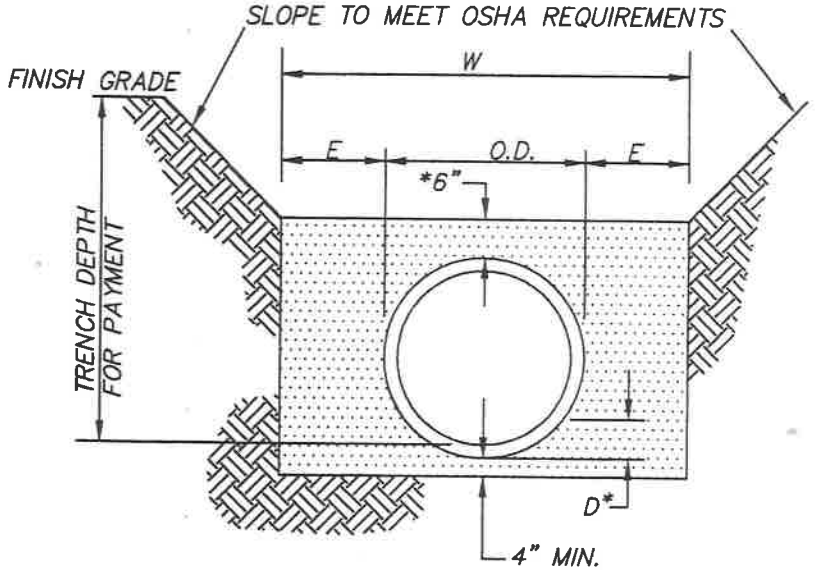
a. The following attached drawings are made part of this specification.

\\Server\projects-m\03-202\Specs\section8.wpd

* MIN. DEPTH OF BEDDING FOR DUCTILE IRON PIPE 1/8 OF THE PIPE DIAMETER. FOR ALL OTHER PIPE THE BEDDING SHALL EXTEND TO 6" OVER TOP OF PIPE.

BEDDING MATERIAL SHALL BE CRUSHED LIMESTONE OR WASHED AND CRUSHED GRAVEL CONFORMING TO THE GRADATION REQUIREMENTS OF A.S.T.M. C-33 SIZE 67 AS SHOWN BELOW.

PASSING	1 INCH SIEVE	100%
PASSING	3/4 INCH SIEVE	90 - 100%
PASSING	3/8 INCH SIEVE	20 - 55%
PASSING	NO. 4 SIEVE	0 - 10%
PASSING	NO. 8 SIEVE	0 - 5%

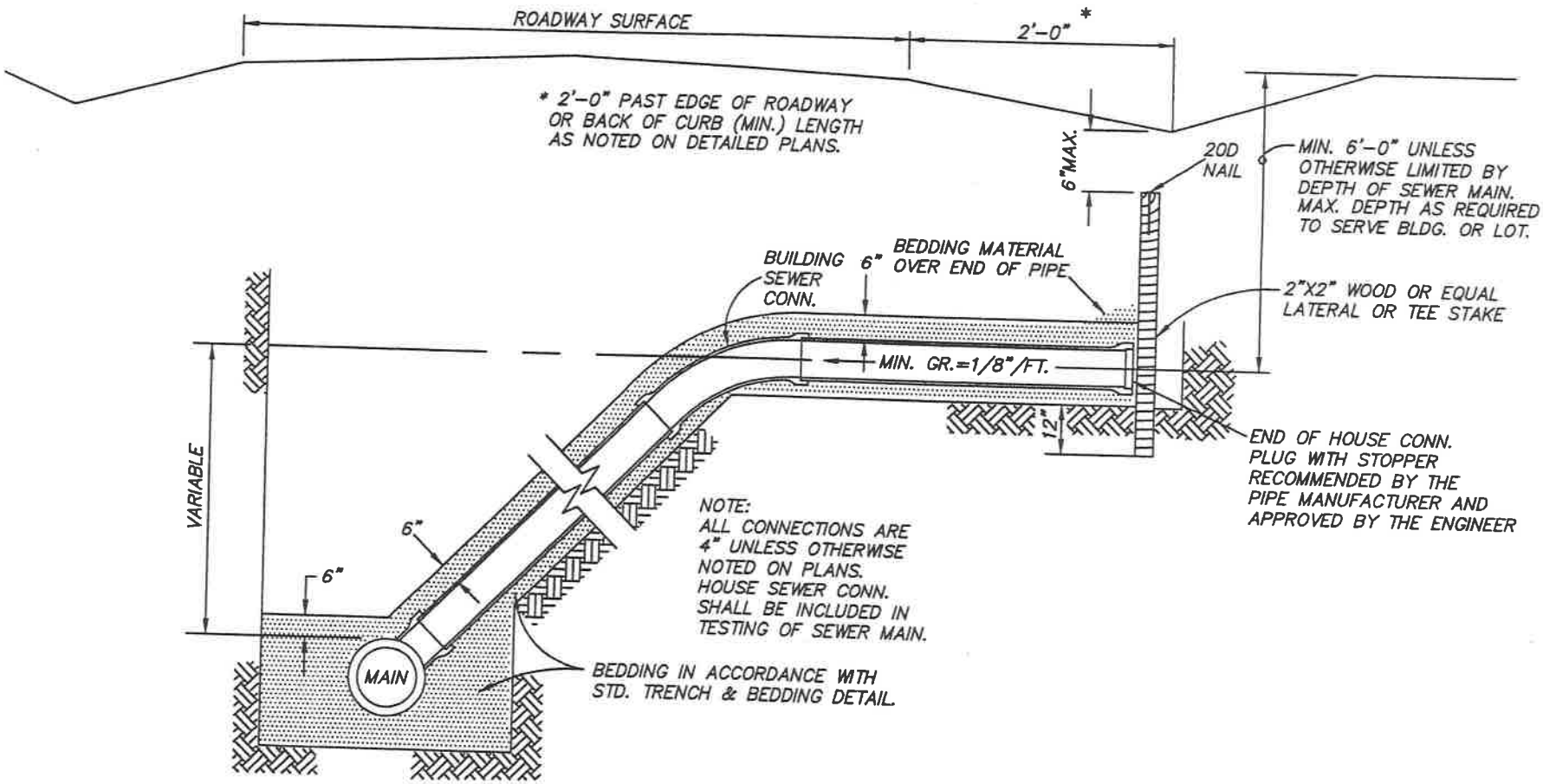


STANDARD TRENCH & BEDDING DETAIL

(GRAVITY PIPE)

FILE: TRENCH 6-25-03

SEWER SYSTEM DETAIL

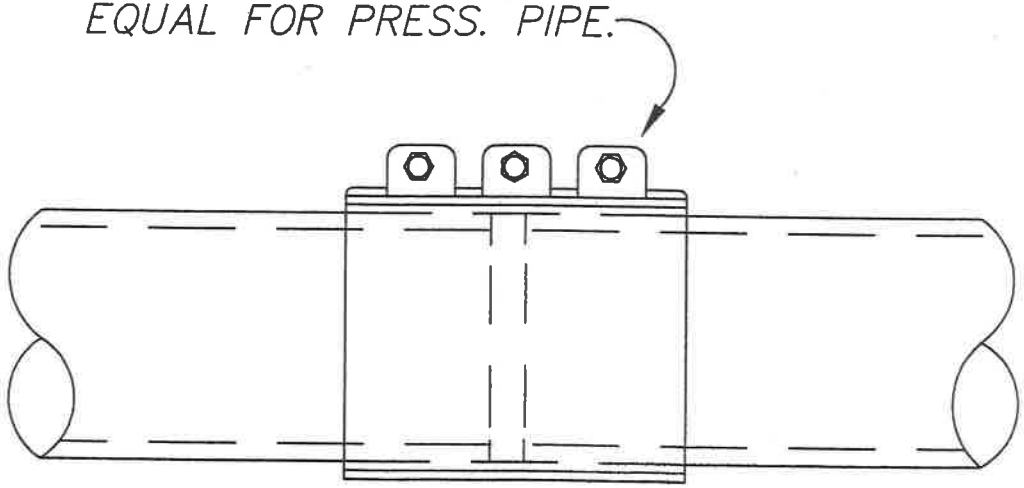


STANDARD BUILDING SEWER CONNECTION UNDER ROADWAY

FILE: HOUR 6-25-03

SEWER SYSTEM DETAIL

FULL CIRCLE STAINLESS STEEL
CLAMP "ROCKWELL # 226" OR
EQUAL FOR PRESS. PIPE.

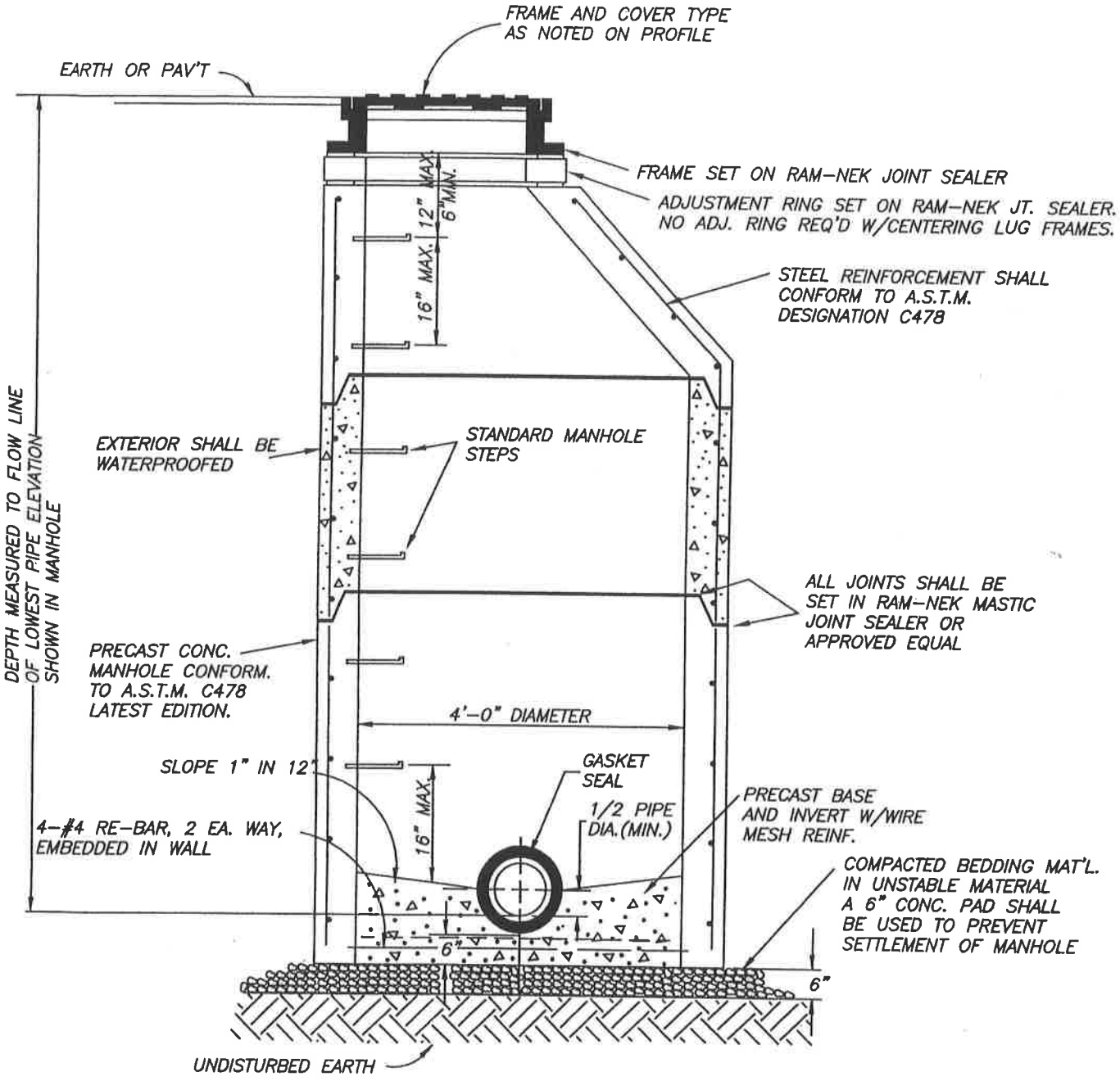


FERNCO CPL. W/STAINLESS STEEL
SHEAR RING FOR GRAVITY PIPE.

DISSIMILAR PIPE OR REPAIR CONNECTION DETAIL

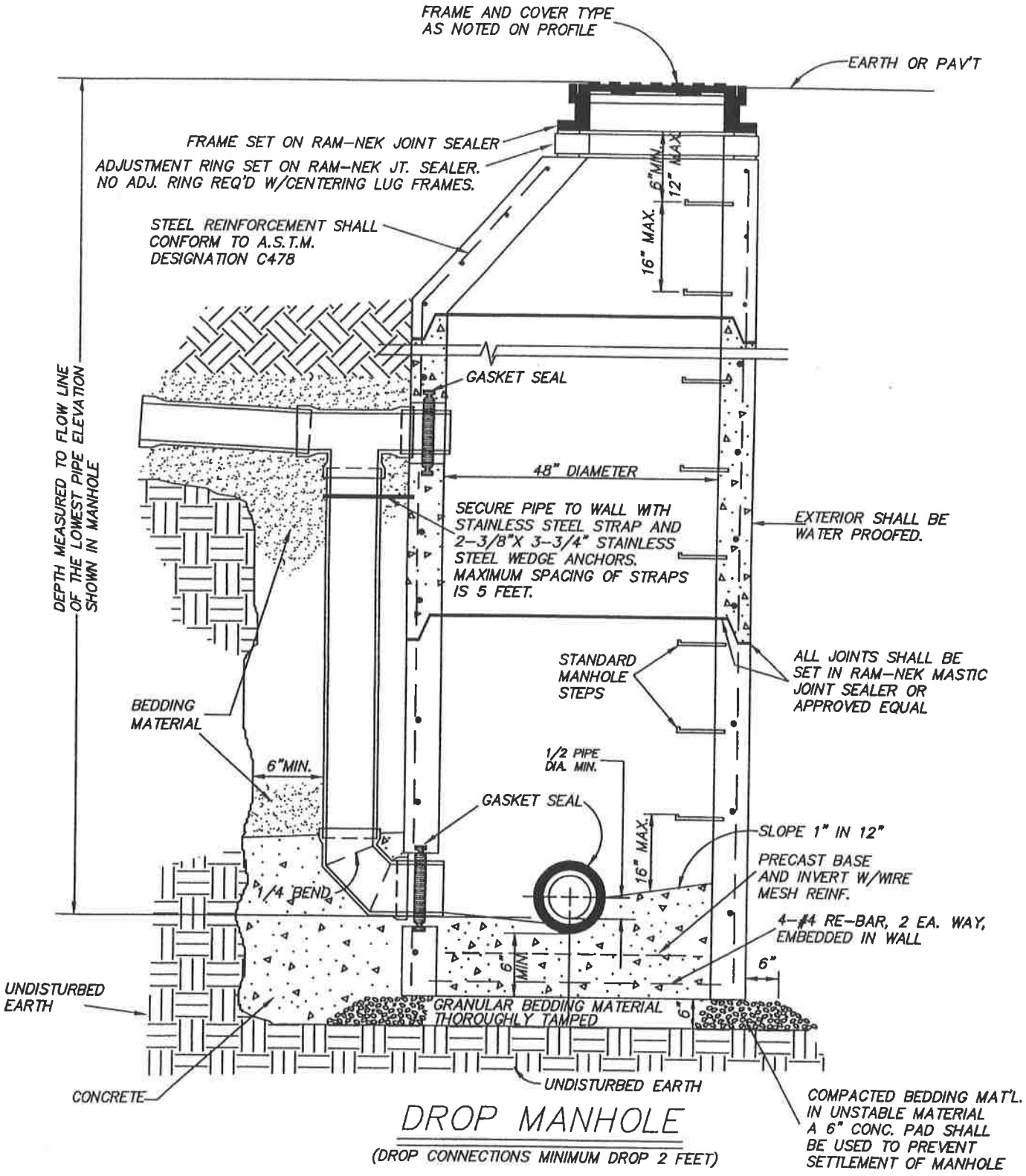
SEWER SYSTEM DETAIL

FILE: SPLICE 6-25-03



PRECAST MANHOLE WITH PRE-CAST BASE AND INVERT

SEWER SYSTEM DETAIL

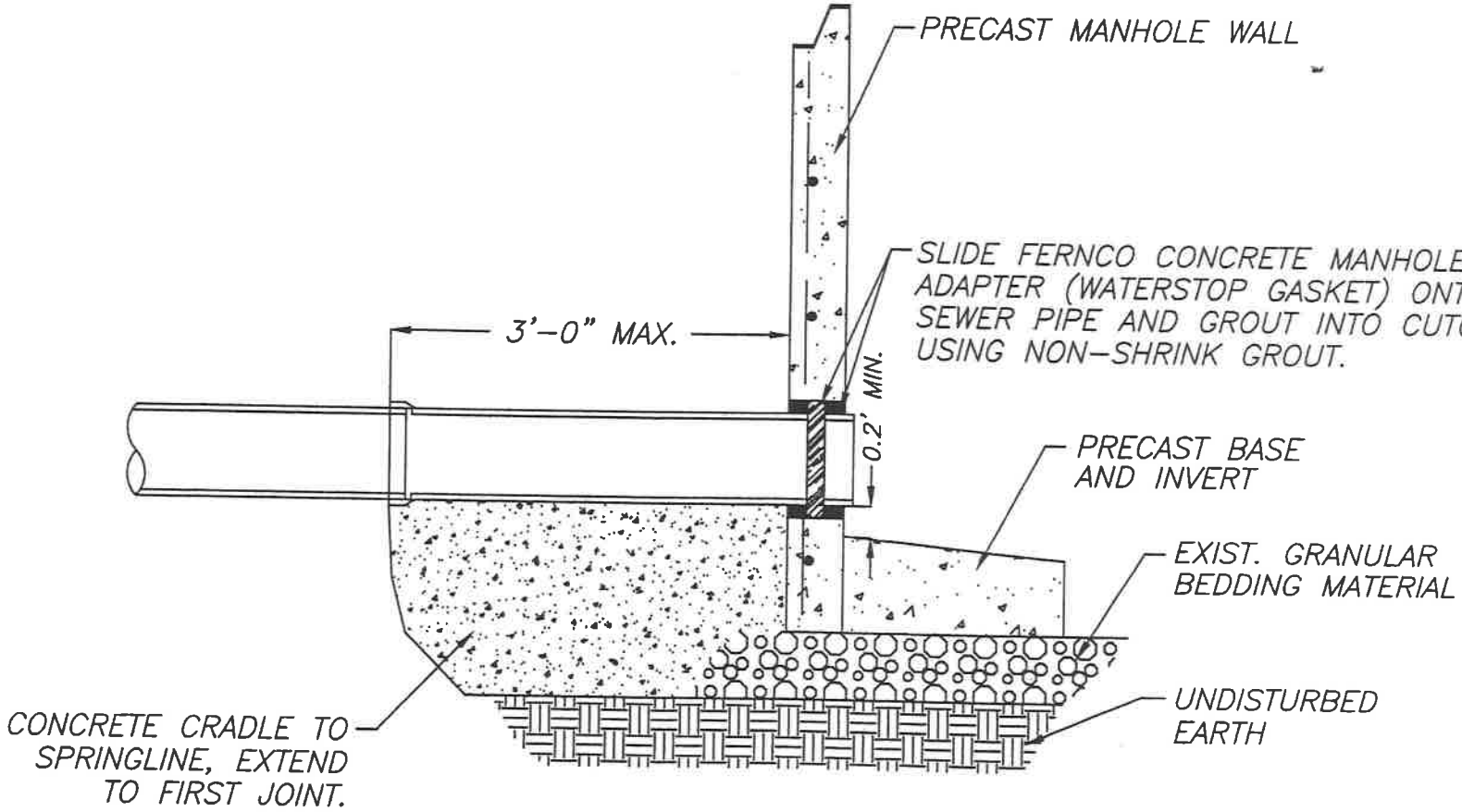


DROP MANHOLE

(DROP CONNECTIONS MINIMUM DROP 2 FEET)

FILE: CSDMH 8-25-03

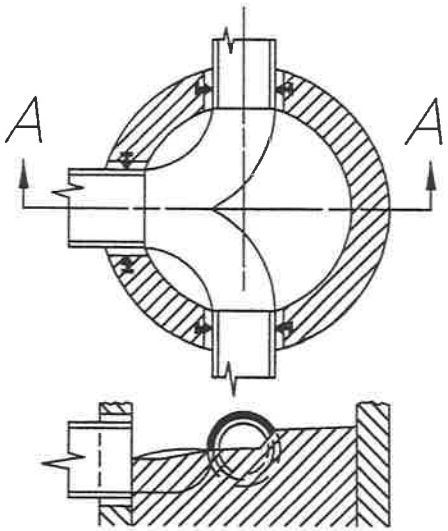
SEWER SYSTEM DETAIL



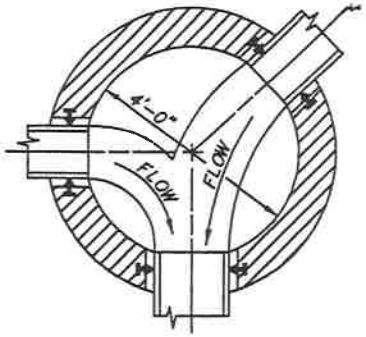
EXISTING MANHOLE CONNECTION

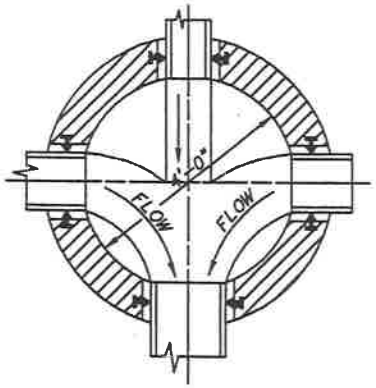
FILE: MHCONNECT 6-25-03

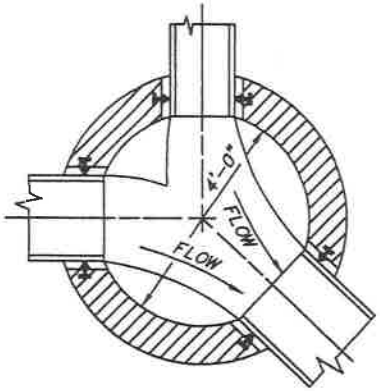
SEWER SYSTEM DETAIL



SECTION A–A

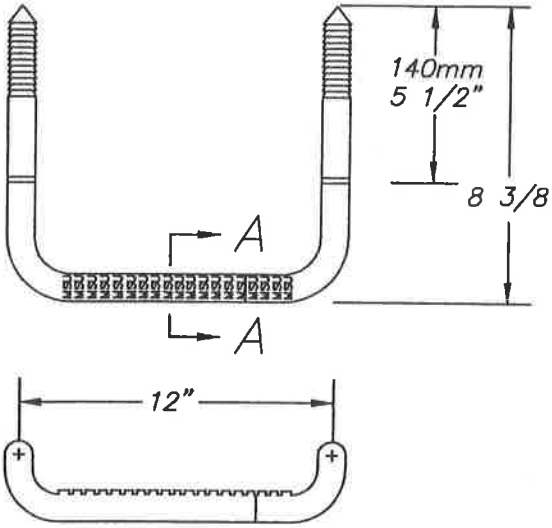


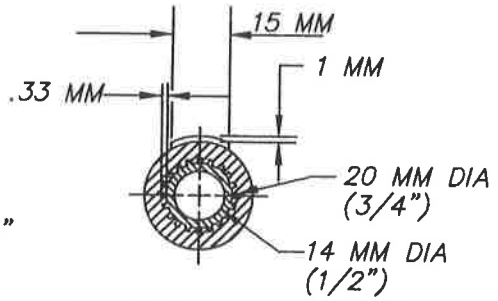




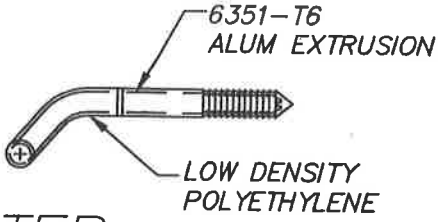
PLANS FOR MANHOLE INVERTS

FILE: INVERT 6-25-02



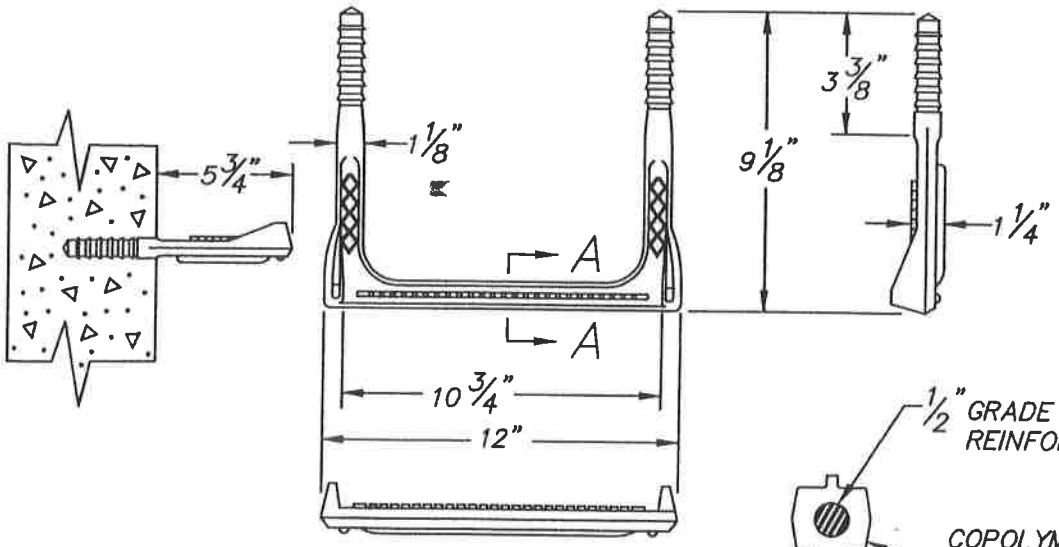


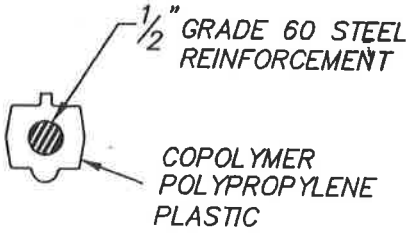
SECTION A–A
EXTRUSION DETAIL



MANHOLE STEP

MSU MISSISSAUGA LIMITED MODEL 360
DRIVE–IN STYLE MANHOLE RUNG





MANHOLE STEP

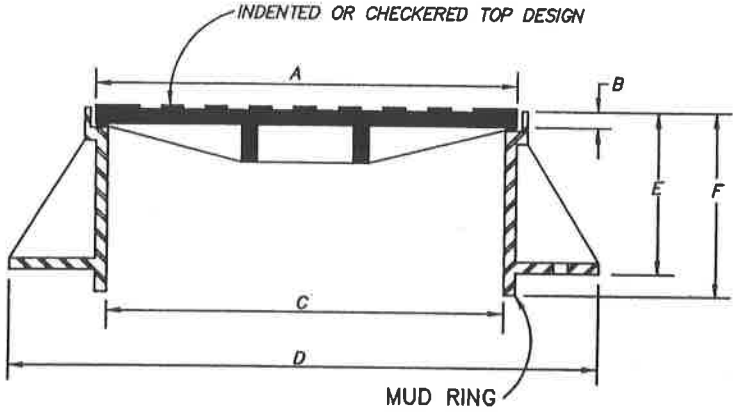
M.A. INDUSTRIES INC. PS1–PF

SECTION A–A

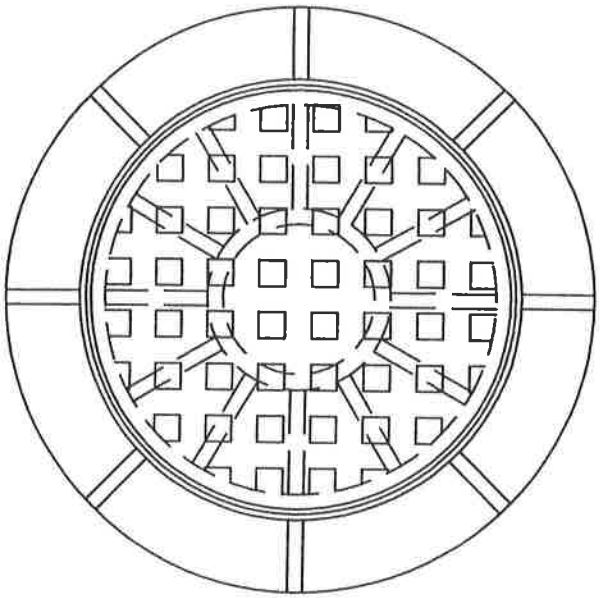
SEE SEWER LINE PROFILE FOR FRAME AND COVER TYPE

FRAME & COVER	A	B	C	D	E	F	WT.
STANDARD TYPE	23 1/4"	1 1/4"	22"	34"	9"	10"	415 LBS.
BOLT DOWN	25 1/2"	1 1/2"	22 3/4"	34"	9"	10 1/4"	440 LBS.

DIMENSIONS IN TABLE FROM DEETER CATALOG "D"/SIXTH EDITION

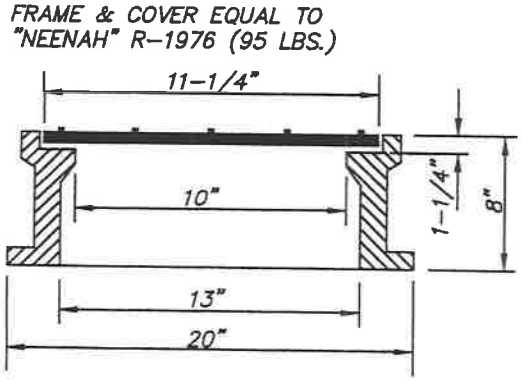


SECTION

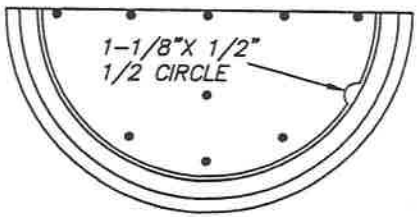


STANDARD MANHOLE FRAME & COVER

STANDARD TYPE EQUAL TO DEETER CAT. NO. 1315
BOLT DOWN TYPE EQUAL TO DEETER CAT. 1310
FRAME & COVER SHALL BE CAST IRON MEETING ASTM A-48-76 CLASS 30/MIN.

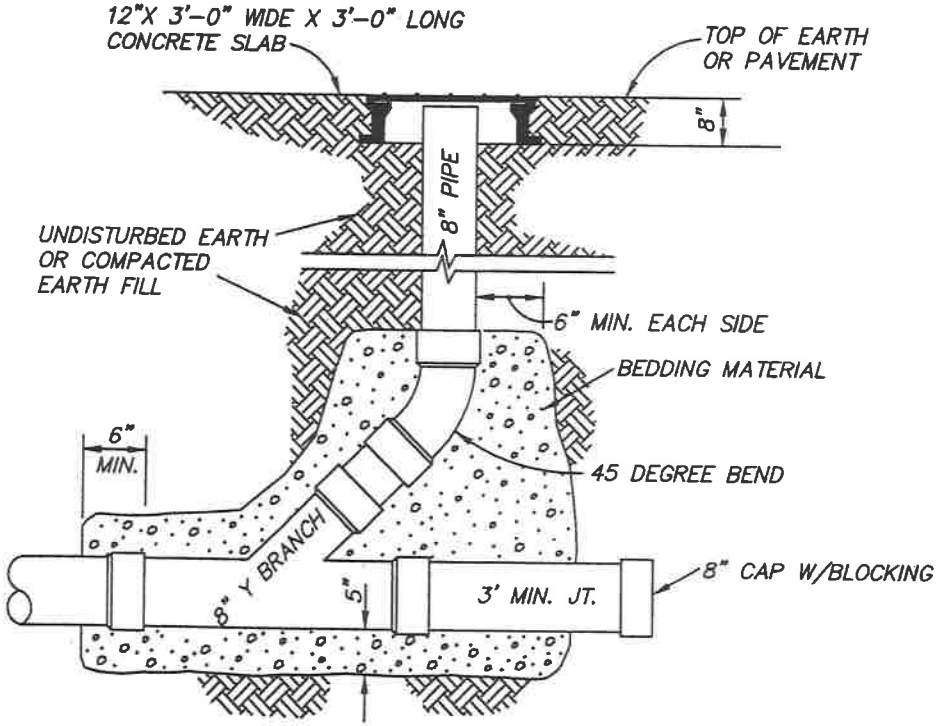


SECTION



HALF PLAN

LAMPHOLE FRAME & COVER



STANDARD CLEANOUT LAMPHOLE

FILE: LAYOUT 6-25-03

SEWER SYSTEM DETAILS

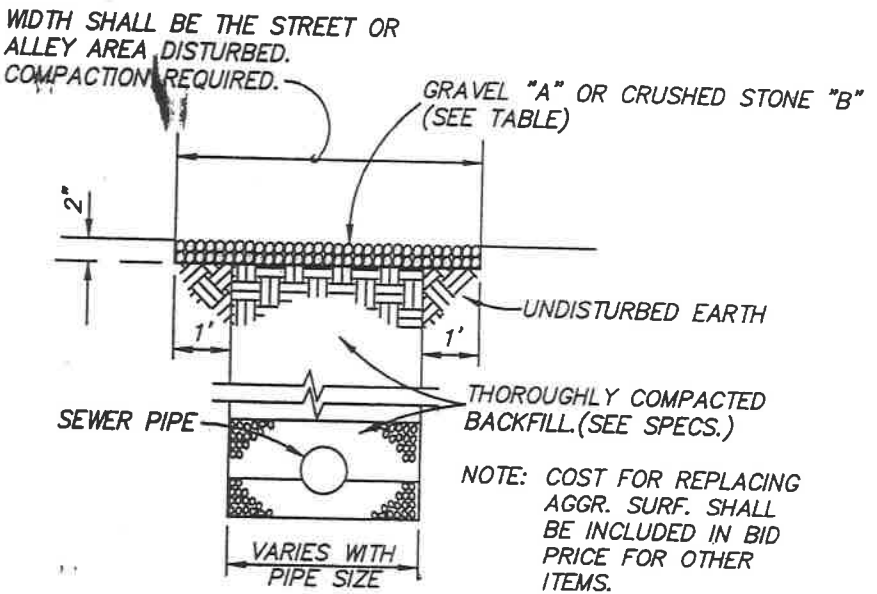
AGGREGATE SURFACING MATERIAL

GRADE	KIND OF MAT'L	PERCENT PASSING BY WEIGHT					
		SIEVE SIZES					
		1"	3/4"	3/8"	NO.4	NO.10	NO.200
A	GRAVEL	100	80–100	----	< 60	10–35	0–10
B	CRUSHED STONE	100	----	< 65	----	5–25	----

NOTE: "<" INDICATES MAXIMUM PERMITTED

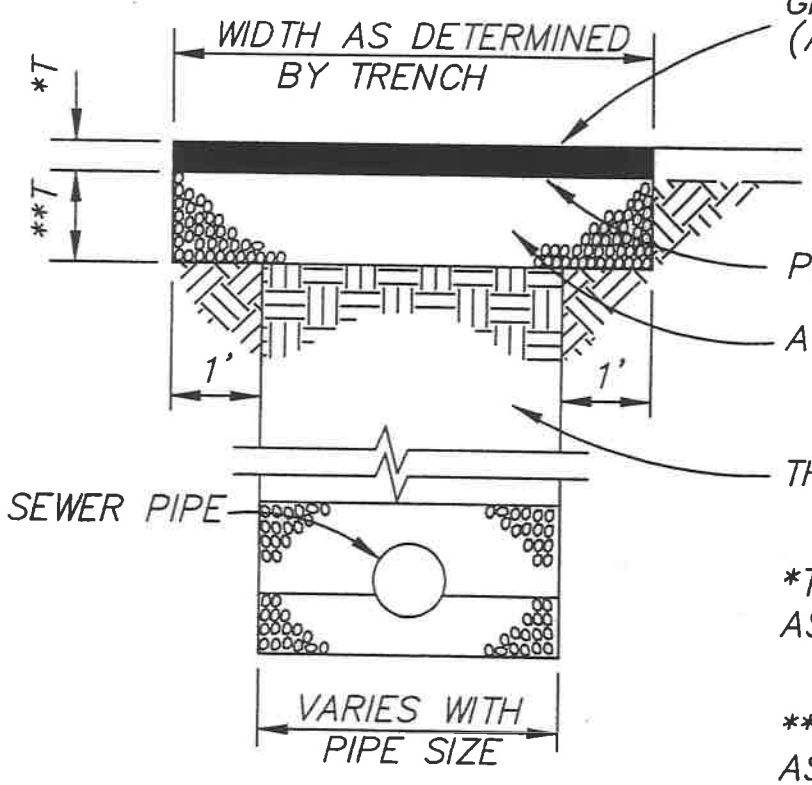
AGGREGATE BASE MATERIAL
(LIMESTONE OR DOLOMITE)

	PERCENT
PASSING 1–INCH SIEVE	100
PASSING 1/2–INCH SIEVE	60–90
PASSING NO. 4 SIEVE	40–60
PASSING NO. 40 SIEVE	15–35



NOTE: COST FOR REPLACING AGGR. SURF. SHALL BE INCLUDED IN BID PRICE FOR OTHER ITEMS.

TYPE 1



GRADE BP-2 PLANT MIX BITUMINOUS PAVEMENT (ACCORDING TO MO. STATE HWY. DEPT. SPECS.)

PRIME COAT AT 0.35 GAL. PER SQ. YD.

AGGREGATE BASE MATERIAL (SEE TABLE)

THOROUGHLY COMPACTED BACKFILL (SEE SPECS.)

*THICKNESS OF ASPHALT SHALL BE THE SAME AS THAT REMOVED BUT IN NO CASE LESS THAN 2"

** THICKNESS OF BASE MAT'L. SHALL BE THE SAME AS THAT REMOVED BUT IN NO CASE LESS THAN 6".

TYPE 3

E: SRTYPE3 6-25-03

SEWER SYSTEM DESIGN

SECTION IX

WET WELL MOUNTED SEWAGE PUMP STATION

SPECIFICATION

1. General
2. Operating Conditions
3. Pump Chamber
4. Welding
5. Protection Against Corrosion
6. Pumps.
7. Motors
8. Controls
9. Environmental Equipment
10. Station Piping
11. Audio/Visual Alarm
12. Spare Equipment
13. Factory Tests
14. Installation and Operating Instructions
15. Guarantee
16. Electric Service
17. Fencing
18. Wet Well
19. Pump Station Drawings

SPECIFICATIONS
FOR
WET WELL MOUNTED PUMP STATION

1. General:

The Contractor shall furnish and install factory-built, automatic pumping station(s) including all equipment and appurtenances as noted on the plans and approved shop drawings. Unless approved by the city, the manufacturer shall be Smith and Loveless, generally matching the existing stations currently in service.

The principal items of equipment for each station shall include two close-coupled, motor driven, vacuum primed, non-clog sewage pumps; valves; internal piping; central control panel with circuit breakers; motor starters and automatic pumping level controls; heater; priming pumps and appurtenances; ventilator; and all internal wiring.

2. Operating Conditions:

Each pump shall be capable of delivering the rated flows of raw unscreened sewage against the total dynamic heads as shown on the plans. The maximum allowable speed shall be 1800 RPM. The minimum rated horsepower of each pump motor and the maximum static suction lift shall also be as noted on the plans.

Normal design condition shall be the Pump Off elevations and the force main "c" of 120. Maximum motor Hp shall be determined using the normal design impeller size, the elevation of over flow from the wet well or manholes, and a "C" of 150.

All openings and passages shall be large enough to permit the passage of a sphere 3" in diameter and any trash or stringy material which can pass through a 4" building sewer system.

3. Pump Chamber:

The station shall be constructed in one complete factory-built assembly. It shall be sized to rest on the top of the wet well as detailed in the construction drawings. The supporting floor plate shall be minimum 3/8" thick steel with broken down edges or other reinforcing, to provide a rigid support.

The pump station shall be enclosed by a hinged fiberglass cover. The cover shall have a suitable drip-lip around the edge and shall be provided with a hasp and staple connection to the floor plate to allow the pump chamber to be locked with a padlock. A resilient rubber seal shall be provided to provide a seal between the cover and the floor plate.

The cover shall have a latch mechanism to keep the cover open under load. A second cover support cable or chain for the opposite side of the latch shall be provided to stabilize the cover in the open position. Adjustable ventilating louvers shall be provided on each end of the fiberglass cover which are capable of being closed during cold weather operation.

A 1/4" aluminum manway cover located exterior to the fiberglass pump chamber shall be provided, complete with padlocking provisions. The manway shall be an integral part of the station floor plate and provide access to the wet well.

The pump volutes and discharge piping shall be mounted in relation to the floor plate as detailed in the construction drawings.

4. Welding:

All steel structural members shall be jointed by electric arc welding with welds of adequate section for the joint involved.

5. Protection Against Corrosion:

After welding, all inside and outside surfaces of the structure shall be blasted with steel grit to remove rust, mill scale, weld slag, etc. All weld spatter and surface roughness shall be removed by grinding. Surface preparation shall comply with SSPC-SP6, commercial blast cleaning, specification. Immediately following the cleaning, a single epoxy primer and a single epoxy finish coating shall be factory applied to all inside and outside surfaces prior to shipment. Paint system shall be equal to Tnemec Hi-Build Epoxoline Series 66, with a minimum dry film thickness of 6 mils obtained. Aluminum or stainless steel shall not be coated. A touch-up kit shall be provided to allow the contractor to repair scratches, etc. The kit shall contain exact color match coating and detailed instructions for use.

6. Pumps:

The pumps shall be non-clog sewage pumps of heavy cast iron construction especially designed for the use of mechanical seals and vacuum priming. In order to minimize seal wear caused by lineal movement of the shaft, the shaft bearing nearest the pump impeller shall be locked in place. To minimize seal wear resulting from shaft deflection in the mechanical seal caused by the radial thrust of the pump, the shaft shall be a minimum of 1 7/8" diameter from the top of the impeller through the lower motor bearing supporting the impeller. The dimension from the lowest bearing to the top of the impeller shall not exceed 6".

The bearing nearest the impeller shall be designed for combined thrust and radial load. The upper bearing shall be free to move linearly with the thermal expansion of the shaft and shall be designed for radial load only.

The shaft shall be of solid stainless or carbon steel accurately machined over its length. Carbon steel shafts shall be protected in the wet end by a replaceable stainless steel sleeve.

The pump impeller shall be of the non-clog type made of close-grained cast iron and shall be balanced. The impeller shall have a taper fit and be keyed and secured to the motor pump shaft by a stainless steel cap screw equipped with a Nylock or other suitable self-locking device. To prevent the buildup of stringy materials, grit and other foreign particles around the pump shaft, all impellers shall be full diameter or shall be trimmed inside the impeller shroud. The shroud shall remain full diameter so that close minimum clearance from shroud to volute is maintained. Both the end of the shaft and the impeller bore shall be tapered to permit easy removal.

The pump shall be so constructed so as to permit priming from the low pressure area behind the impeller. Priming from high pressure connections will not be acceptable. The priming bowl shall be transparent to enable the operator to monitor the priming level.

The pump shall be arranged so that the rotating element can easily be removed from the volute without disconnecting the electrical wiring or disassembling the motor, impeller, backhead or seal, so that any foreign object may be removed from the pump or suction line.

The pump shaft shall be sealed against leakage by a single mechanical seal constructed so as to be automatically drained and primed each time the pump is drained and primed. Water which lubricates the mechanical seal shall be automatically drained from around the seal if the pump loses prime.

The seal shall be of carbon and ceramic materials with the mating surfaces lapped to a flatness tolerance of one light band. The rotating ceramic shall be held in mating position with the stationary carbon by a stainless steel spring.

The pump volute shall be furnished with mounting lugs and be bolted to the station floor, forming a gas-tight seal.

7. Motors:

The pump motors shall be vertical, solid shaft, NEMA JM, JP or P-base, squirrel-cage induction type, suitable for three phase, sixty cycle, 480 volt, electric current. They shall have Class F insulation, suitable for temperatures up to 105°C. Insulation temperature shall, however, be maintained below 80°F. The motors shall have normal starting torque and low-starting current, as specified by NEMA Design B characteristics. They shall be open drip-proof design with forced air circulation by integral fan. Openings for ventilation shall be uniformly spaced around the motor frame. Leads shall be terminated in a cast connection box and shall be clearly identified.

The motors shall have 1.15 service factor. The motors shall not be overloaded beyond their nameplate rating, at the design condition, nor at any head in the operating range as specified.

The motor-pump shaft shall be centered, in relation to the motor base, within .005". The shaft runout shall not exceed .003".

The motor shaft shall equal or exceed the diameter specified under pumps, at all points from immediately below the top bearing to the top of the impeller hub.

The bearing cap shall be provided to hold the bottom motor bearing in a fixed position. Bearing housings shall be provided with fittings for lubrication as well as purging old lubricant.

The motor shall be fitted with heavy lifting eyes, each capable of supporting the entire weight of the pump and motor.

8. Controls:

The control equipment shall be mounted in a NEMA Type 1 steel enclosure with a hinged access cover. The circuit breakers, overload reset buttons, run time meters, and control switches shall be operable without opening the access cover. All switches and indicating lights shall be heavy duty oil tight design. Dry type transformer shall be provided for 115 VAC loads.

Thermal magnetic circuit breakers shall be provided for branch disconnect service and short circuit protection of all motor control and auxiliary circuits. Industrial grade switchgear shall be used.

NEMA rated magnetic across-the-line starters with under voltage release and overload coils for each phase shall be provided for each pump motor to give positive protection against single phasing. Each single phase auxiliary motor shall be equipped with an over-current protection device in addition to each branch circuit breaker, or shall be impedance protected. All switches shall be labeled and a color-coded wiring diagram shall be provided.

If the local utility does not allow full voltage starting, then a solid state reduced voltage starter shall be used. Solid state reduced voltage starters shall be Allen-Bradley or Square D.

A running time meter shall be supplied for each pump to show the number of hours of operation. The meter shall be enclosed in dust and moisture-proof molded plastic case. The flush mounted dial shall register in hours and tenths of hours up to 99999.9 hours before repeating. The meter shall be suitable for operation from a 115 volt, 60 cycle supply.

A separate and independent priming system shall be furnished for each sewage pump, providing complete standby operation. Each priming system shall include separate vacuum pumps and shall have corrosion resistant internal components. They shall each be capable of priming the sewage pump and suction piping in not greater than 60 seconds, under rated static suction lift conditions of 20' at mean sea level.

Each priming system shall be complete with vacuum pump, vacuum control, three-way solenoid valve, prime level sensing probe and a float operated check valve installed in the system ahead of the vacuum pump to prevent liquid from entering the vacuum pump. The float operated check valve shall have a transparent body for visual inspection of the liquid level and shall be automatically drained when the vacuum pump shuts off.

The priming system shall automatically provide positive lubrication of the mechanical seal each time the sewage pump is primed. To prevent excessive stoppage due to grease accumulation, no passageway in the priming system through which sewage must pass shall be smaller than the equivalent of a 2 1/2" opening. Priming shall take place on the suction side of the pump impeller.

To control the operation of the pumps with variations of sewage level in the wet well, three mercury displacement switches shall be provided with sufficient cord to eliminate splices. The cord shall have a corrosion resistant vinyl jacket and be multi-stranded. The switches shall be sealed in a solid polyurethane float and lead weighted. A mercury displacement switch shall also be provided to sense a high water level condition in the pump station wet well. The switch shall activate a single pole double throw relay to indicate the high water condition.

An automatic alternator with manual switch shall be provided to change the sequence of operation of the pumps every eight hours or with each pump cycle. The manual switch shall allow for either pump to be selected as base pump or for automatic alternation.

A time delay relay shall be provided to delay the lag pump start after a power failure. Provisions shall also be made for the pumps to operate in parallel should the level in the wet well continue to rise above the starting level for the low level pump.

A terminal strip with box type connectors shall be supplied to make all power and control connections for both pumps. A ground terminal strip shall also be provided. All terminals shall be marked for easy identification. Rubber compression grommets shall be used to seal the cords through the floor plate to secure the float positions and to seal the station chamber from the wet well. The pump control panel shall be completely wired at the factory, except for power feeder lines. All wiring in the pump control panel shall be numerically or color coded and all switches labeled as indicated on the wiring diagram. Wiring diagrams matching the unit shall be provided.

9. Environmental Equipment:

A ventilating blower shall be provided which is capable of delivering 250 CFM of air in order to remove heat generated by continuous motor operation. The ventilating blower shall be turned on and off by a pre-set thermostat. Louvers which are capable of being closed for cold weather operation shall be installed in each end of the fiberglass cover. The blowers shall be rigidly mounted and its discharge shall have a thick resilient gasket which will match with the louvered opening to seal the discharge when the cover is closed.

An electric heater controlled by a pre-set thermostat shall be furnished. The heater shall be rigidly mounted in the station to prevent removal and be not less than 1,500 watts rated.

10. Station Piping:

The pump suction shall be drilled and tapped for a 125 pound American Standard flange for ready connection to the suction riser provided by others. The discharge line from each pump shall be fitted with a clapper type or ball type check valve and an eccentric full port plug valve. The clapper type check valve shall be of the spring-loaded type with external lever arm and a replaceable resilient seat to insure air-tight sealing. Check valves shall have stainless steel shaft with replaceable bronze shaft bushing and shall be sealed with an adjustable Teflon seal. The common discharge pipe shall be provided with a dresser type sleeve coupling to connect to either steel or cast iron piping. The discharge valves shall be above the base plate. All valves must be capable of passing a 3" sphere.

Suction and discharge piping shall be extended through the station base plate so all field connections are made within the wet well. A positive seal around the suction and discharge must be provided to prevent wet well fumes from entering the station chamber.

11. Audio/Visual Alarm:

To indicate high water in the wet well, an audio-visual alarm shall be provided for operation on 115 volt, single phase power.

To indicate a loss of power, a audio-visual alarm shall be provided for operation by a 12 VDC power supply.

The audio/visual alarm systems shall be housed in a NEMA 4 stainless steel enclosure mounted at the location shown in the plans.

The audio alarm shall consist of two vibratone horns suitable for outdoor mounting, with an audio output of at least 85 db. A silencing switch shall be provided for each.

The visual alarm shall be a vapor-proof light fixture with flashing 100 watt, 115 VAC and a 50 watt DC lamp suitable for outdoor mounting, with red globes and guard. The visual alarm shall continue to flash until the alarm condition has been cleared.

The battery system shall include a maintenance free lead-calcium permanently sealed battery, a trickle charger with fast or float recharge modes.

A push-to-test feature shall be provided in the pump control panel to indicate the alarm devices are functioning properly. The systems shall reset automatically once the alarm condition ends.

12. Spare Equipment:

The following spare equipment shall be supplied with each wet well mounted pump station:

2	Spare mechanical seal assemblies
6	Spare casing gaskets
1	Spare mercury float switch and conductor
1	Alternator relay
1	Control relay of each type used
1	Vacuum pump repair kit

13. Factory Tests:

All components of the pump station shall be given an operational test of all equipment at the factory to check for excessive vibration, for leaks in all piping or seals, and for correct operation of control system and all auxiliary equipment.

The pump suction and discharge lines shall be coupled to a reservoir and the pump shall recirculate water under simulated service conditions.

14. Installation and Operation Instructions:

Installation of the pump chamber shall be done in accordance with the written instructions as provided by the manufacturer.

The manufacturer's field representative shall provide start-up services to check the pump station(s) for proper installation and to instruct the owner's personnel on recommended operation and maintenance procedures.

Six (6) copies of an Operation and Maintenance Manual giving detailed step-by-step operating, maintenance, and troubleshooting procedures for all pump station components including control panel, vacuum priming system and sewage pumps shall be provided to the Engineer, who will provide four (4) copies to the city.

15. Guarantee:

The contractor and manufacturer of this equipment shall provide to the city a one (1) year guarantee, from the date of acceptance for parts and labor to correct any material or installation problems.

16. Electric Service:

Between the utility company meter and the station control panel, the contractor shall install a double throw switch unless a auxiliary power supply is provided. The double throw switch shall be mounted on a uni-strut frame on the utility company service pole or on an acceptable rack near the station. Mounted to the double throw switch shall be a Meltric Brand, 100 amp appliance inlet to match the city's portable electric generator connection plug. Power surge and lightning protection shall provided.

17. Fencing:

The design shall provide for the contractor to furnish and install 6 ft. high chain link fencing and gate. All chain link fencing and installation shall be in accordance with the "Chain Link Fence Manufacturer's Institute" specifications.

The contractor shall furnish and install a 6 ft. high chain link fence and gate as noted on the plans. Line posts shall be set at intervals not to exceed 10 ft. Where conditions require, a shorter spacing shall be used. All posts shall be set true and plumb with the post holes backfilled with 2000 psi (4 sack mix) concrete to finish grade. Line post holes shall be 12" diameter, 38" deep with 36" concrete embedment. The fence fabric shall be stretched taut approximately 2" above the ground securely fastened to the posts and top rails. Stretcher bars shall be fastened to corner posts at 15" intervals. Fabric shall be fastened to line post at 15" intervals using tie wire, metal bands, or other approved methods. The top edge shall be fastened to the top rail at 24" intervals. Fabric splicing shall be done by weaving a single strand into the ends of rolls to form a continuous mesh. Where required, the top rails shall be bent to form a radius. Bending shall be done such that the zinc coating is not damaged.

The fence fabric shall be a 2" x 2" mesh installed using standard line post, corner post, railing, hardware, and bracing. Fence fabric shall be 9 ga. steel wire with zinc-coating by the hot-dip or electrolytic process. Fabric shall be knuckled on the bottom and twisting and barbing at the top

Corner, end, and pull posts shall be standard round 2.875" O.D., 5.79 lb/ft., zinc-coated. Gate posts shall be standard round 4.00" O.D., 9.1 lb/ft., zinc-coated. Line posts shall be standard round 1.90" O.D.,2.72 lb/ft., zinc-coated. Top rails shall be standard round 1.66" O.D., 1.806 lb/ft., 18 ft. lengths with coupling connection, zinc-coated.

Gates shall be swing type complete with latches, stops, keepers, hinges with provisions for three (3) strands of barbed wire above the fabric. Gate frames shall be constructed of tubular members, welded at all corners or assembled with fittings. Welds shall be painted with aluminum based or zinc based paint. Frame members shall be 1.90" O.D., 2.72 lb/ft., zinc-coated. Gates shall be braced as required for the installation. Fabric shall be the same as for fencing.

Three (3) strands of barbed-wire shall be installed above the fence fabric on support arms. Barbed wire shall be 12 ga. wire, 14 ga. 4 point barbs, at 5" intervals and zinc-coated.

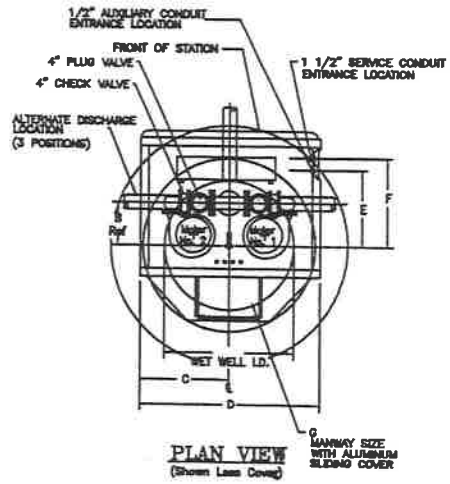
Hardware shall include corner post top, line post top piece with hole for rail, stretcher bars, bands, ties, or clips and other items required for a complete installation.

18. Wet Well:

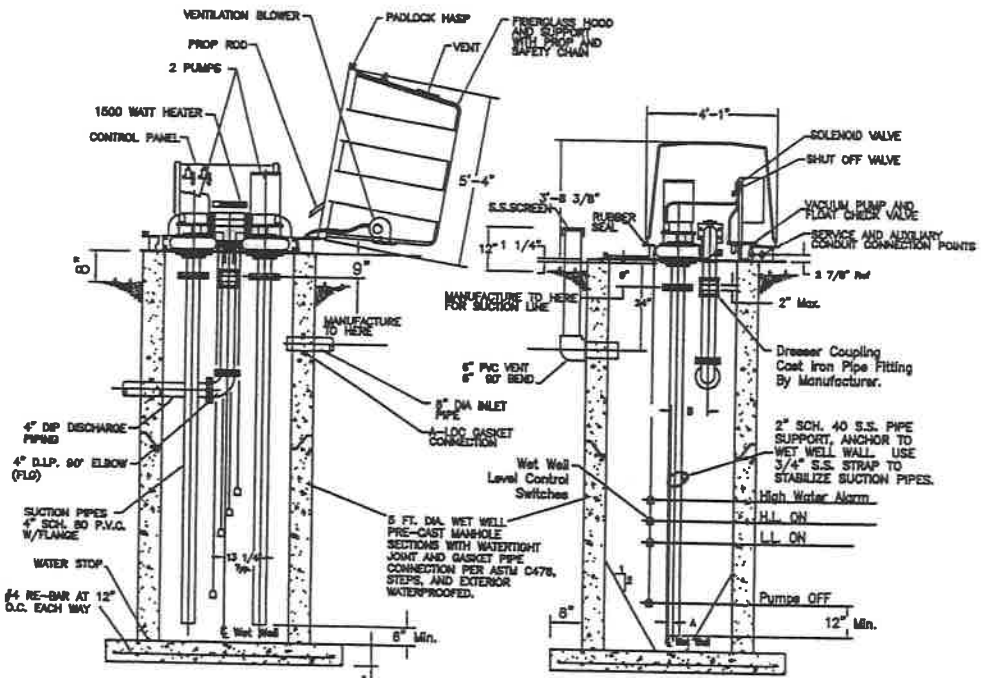
The pump station shall set on a reinforced concrete wet well. A minimum diameter of 5 ft. is required. The pipe entries into the wet well side shall be through gasketed connections, equal to A-Lok. The wet well shall have a sloping concrete invert. The station mounting plate shall be firmly anchored to the top of the wet well. The station suction pipes shall be a minimum 4" diameter, Sch. 40 PVC with solvent welded flanged or 4" D.I.P. with flanged. The suction pipes shall be cross braced using 2" stainless steel pipe, brackets, and fasteners.

19. Pump Station Drawings:

The attached drawings are made a part of this specification.

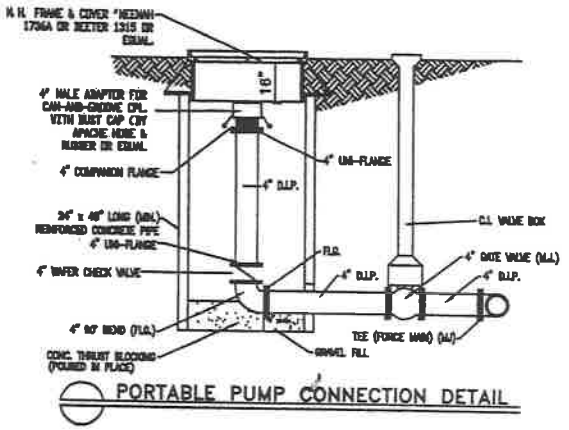


PLAN VIEW
(Shown Less Cover)



SECTIONAL ELEVATION

CROSS SECTION



PORTABLE PUMP CONNECTION DETAIL

WET WELL DIAMETER	DIM A	DIM B	DIM C	DIM D	DIM E	DIM F	MANWAY G
5'-0"	8"	19 13/16"	34"	88"	31 3/8"	35 7/8"	24 1/2" x 28"

SECTION X

DUPLEX GRINDER PUMP STATION

SPECIFICATIONS

1. Scope of Work
2. Performance Requirements
3. Manufacturers
4. Construction
   - A. Pump(s)
   - B. Motor(s)
5. Electrical
6. Pump Chamber
7. Access Frame and Cover
8. Guide Rail System
9. Factory Tests
10. Installation and Operating Instructions
11. Spare Parts
12. Guaranty
13. Electric Service
14. Fencing
15. Pump Station Drawings

SPECIFICATIONS
FOR
DUPLEX GRINDER PUMP STATION

1. SCOPE OF WORK:

Under this specification, the contractor shall furnish and install duplex submersible automatic grinder pumping station including all equipment and appurtenances as shown in the plans and approved shop drawings.

The principal items of equipment shall include two close coupled, submersible motor driven, grinder sewage pumps; valves and piping; guide rail system; and central panel with circuit breakers, motor starters and automatic pumping level controls.

2. PERFORMANCE REQUIREMENTS:

Each pump shall be capable of delivering the rated flows of shredded sewage against the total dynamic head as shown on the plans. The maximum allowable speed shall be 3450 rpm, the voltage shall be 240 V. 1-phase or 480 V. 3-phase, and the minimum rated horsepower of each pump motor shall be 3Hp.

The number of homes or flow shall not exceed the manufacturers recommendations.

The pumps shall be capable of operating throughout the range of the impeller curve without overloading the motor.

The pumps, motors and guide rail system shall be designed for Class 1, Group D, Division 1, hazardous locations.

3. MANUFACTURERS:

In accordance with this specification, furnish submersible grinder pump system(s) as manufactured by Myers, and similar in design and operation to the original system pumps of this type.

4. CONSTRUCTION:

A. Pump(s) - Each pump shall be a centrifugal type grinder pump with recessed type impeller and integrally built-in grinder assembly and completely submersible motor. Pump shall be installed on a lift-out rail type system in such a way that solids are fed in an up-flow direction to the grinder impeller with no feet, rails, or other obstruction below grinder inlet.

The pump impeller shall be of the multi-vane, recessed type to provide an open unobstructed passage through the volute for the ground solids. Impeller shall be of 85-5-5-5 bronze and shall be threaded onto stainless steel shaft.

The grinder assembly shall be capable of macerating all material in normal domestic and commercial sewage including reasonable amount of foreign objects such as wood, plastics, glass, rubber, sanitary napkins, disposable diapers and the like into a fine slurry.

The grinder assembly shall consist of grinder impeller and shredding ring and shall be mounted directly below the volute passage. Grinder impeller to be threaded onto stainless steel shaft and be locked in place with screw and washer. The shredding ring shall be pressed into iron holding flange for easy removal. Flange shall be provided with tapped back-off holes so that screws can be used to push the shredding ring from housing. All grinding of solids shall be from action of the impeller against the shredding ring. Both shredding ring and impeller shall be removable from the outside without dismantling the pumps and hardened to 55-60 Rockwell C.

B. Motor(s) - Pump motor(s) shall be of the sealed submersible type suitable for the electric service shown on the plans. Single phase motors shall be of the capacitor start, capacitor run, type for high starting torque.

Stator winding to be of the open type with Class A insulation for operating in clean dielectric oil that lubricates bearings and seals, and cools the windings.

Motors shall have three bearings, two ball bearings to support the rotor and take radial and thrust loads and a single sleeve bearing in the seal chamber to prevent shaft deflections at the lower seal. Ball bearings shall have a B-10 life of 50,000 hours.

A heat sensor thermostat shall be attached to top end of motor winding and shall be connected in series with the magnetic contactor coil in control panel to stop motor if motor winding temperature reaches 220 degrees F. Thermostat to reset automatically when motor cools. Two heat sensors are to be used on 3 phase motors, one sensor for 1 phase motors.

The motor shall be protected by a tandem mechanical seal of the double spring design operating in an oil filled cavity. Seals shall have carbon and ceramic faces Type 21 BF1C1 lapped to a flatness tolerance of one light band. Metal parts and springs shall be stainless steel. An electrode shall be mounted in the seal cavity to detect any water leakage past the lower seal. Electrodes shall be connected to an amber signal light in the control panel.

The common motor, pump and grinder shaft shall be of #416 stainless steel threaded to take pump impeller and grinder impeller.

Motor power and control cords shall be Type SO of sufficient length to suit installation. Both cords shall be potted into motor end cap with epoxy potting compound. In addition, a rubber grommet that seals both cords shall be clamped onto cord by end holding cap. Cords shall withstand a pull of 150 pounds without loosening.

C. Pump and Motor Castings - All castings shall be ASTM A-48, Class 30 cast iron with 300 Series stainless steel hardware.

All iron castings shall be pre-treated with phosphate and chromic rinse and shall be painted with high temperature baked epoxy before machining and all machined surfaces exposed to the sewage water repainted with high temperature baked epoxy.

5. ELECTRICAL CONTROLS:

The pump manufacturer shall supply a completely self-contained Duplex Control Panel to operate the pumps as shown in the control wiring schematic in the plans. The control panel shall provide short circuit and overload protection for each pump. An automatic alternator shall be provided to automatically alternate the lead pump duty between the two pumps on successive cycles. The alternator circuitry shall also provide means to start the lag pump in the event the lead pump capacity is less than the inflow or the lead pump fails. A switch shall be provided to bypass the alternator.

All control elements shall be mounted in a NEMA 4 stainless steel enclosure. The NEMA 4 enclosure shall have a separate inside hinged door to provide for mounting control switches, pilot lights, run time meters and overload reset buttons. Outer door of NEMA 4 enclosure shall have a hasp for padlock and a minimum of 3 draw pull type catches.

A main circuit breaker for each pump shall be mounted with the operating handles through the inside door and shall have a lock arrangement that prevents the door from being opened when breakers are in the "on" position. When breakers are off, all power shall be killed to the control elements. Circuit breakers for auxiliary circuits shall be provided.

A magnetic heavy duty contactor and manual re-set quick trip ambient compensated overload block shall be provided for each motor. Overload coils shall hold with a voltage drop up to 35%. Starters shall be full voltage, NEMA rated.

Motor start and run capacitors, and start relay for single phase motors shall be mounted in control panel.

Heat sensor thermostats in each motor shall be wired in series with the magnetic contactor coil to protect the motor against excessive heat. Thermostats shall reset automatically when motor cools.

A seal leak electrode installed in each pump seal cavity shall be connected to an amber signal light on the control panel inside door.

A run time meter shall be supplied for each pump to show the number of hours of operation. The meter shall be enclosed in dust and moisture-proof molded plastic case. The flush mounted dial shall register in hours and tenths of hours up to 99999.9 hours before repeating. The meter shall be suitable for operation on a 115 volt, 60 cycle power supply.

H-O-A switches, pilot lights, run-time meters and overload reset buttons shall be mounted on the control panel inside door. Switches shall be oil-tight construction. Toggle type switches will not be considered equal.

Sealed displacement type mercury switches shall be supplied to control pump cycling. The mercury switches shall be sealed in a solid polyurethane float for corrosion and shock resistance. Conductor cord shall be a 2-conductor stranded cord with individual insulated wires enclosed in a neoprene jacket. Cords shall be lead weighted at float end and suspended from a support bracket mounted at top of pump chamber.

A terminal strip with box type connectors shall be supplied to make all power and control connections for the pumps. A ground terminal strip shall also be provided. All terminals shall be marked for easy identification.

A high water in the wetwell alarm horn and red light (115 volt), activated by a float switch shall be provided as a part of the control panel for the duplex stations. A separate Audio/Visual Alarm System sensing power loss and battery powered shall be provided as detailed in the Specification section entitled "Wet Well Mounted Sewage Pumping Station"..

The pump control panel shall be completely wired at the factory, except for the power feeder lines. All wiring in the pump control panel shall be numerically or color coded as indicated on the wiring diagram. Wiring diagrams matching the unit shall be provided.

6. PUMP CHAMBER:

The Pump Chamber (wetwell) shall be fabricated from pre-cast manhole sections with pre-cast base. Joints shall be made with Ram-Nek, or equal, joint sealer. Pipe openings for force mains shall be grouted with non-shrink grout and include a water-stop gasket centered in the wetwell wall opening. Gravity lines shall have a flexible, water-tight, gasket connection. The minimum wet well diameter shall be 4 ft.

Equipment installed shall be firmly anchored so that no undue stress exists. All anchoring hardware shall be stainless steel.

7. ACCESS FRAME AND COVER:

A pump chamber access frame and cover shall be provided. The cover shall be rectangular opening made with aluminum frame and hinged aluminum cover and of adequate size to suit installation. A minimum clear opening shall be 24". Cover shall be of diamond pattern no-skid type and shall be provided with lock hasp and manual release hold open arm. Cover shall be designed for load of 300 lbs/sq. ft. All hardware shall be stainless steel.

8. GUIDERAIL SYSTEM:

The lift-out rail system assembly shall permit easy removal and installation of the pump and check valve without the necessity of personnel entering the wetwell. Structural guide brackets with guide yokes of sufficient bearing strength to prevent binding shall bolt to the pump. The yokes shall mate over guide rails of a minimum of 1-1/4 inch pipe running between an upper rail support and the discharge case. A discharge nozzle or flange at the check valve shall be guided into a chamfered cavity or a sealing flange. Dual "O" rings or a resilient seal shall effect a hydraulic seal between the two parts when it is in its operating position.

The discharge case shall be securely bolted to the floor of the wetwell so that slight deflection caused by the discharge pipe will not cause the quick-connect pump flange to leak.

All cast iron parts shall be coated with corrosion resistant baked on epoxy paint.

The lift-out check valve shall be of the swing clapper type with rubber facing. A bronze seat bushing shall be mounted in face of valve to provide a corrosion-proof seat. The clapper shall be mounted on a stainless steel shaft and shall be spring loaded to prevent slamming when closing. An alternate ball-type check valve may be used with a bronze machined sealing face and a resilient ball.

The check valve shall lift out with pump to allow for inspection, cleaning or maintenance of the valve outside the wetwell. All fasteners shall be stainless steel.

An upper guide plate shall be attached to pump to support lift out fitting and guide pump on rails. A lifting eye shall be attached to plate and stainless steel cable and clevis shall be furnished for lifting pump. Each pump shall be equipped with a 3/16" (min) stainless steel lifting cable with provisions for direct connection to the portable crane winch drum allowing continuous lifting of the drum.

Two hold-down brackets shall be provided to prevent pump and seal fitting from rising on rails.

Guide rails shall be 1-1/4" stainless steel pipe and hold-down pipe shall be 1/2" stainless steel pipe.

Rail support and mounting bushing shall be mounted to basin wall and shall not be attached to basin cover or cover frame.

Guide rail support shall be adjustable so that perfect vertical alignment of the rails can be obtained.

9. FACTORY TESTS:

Both submersible pumps and the control panel shall be given an operational test of all equipment at the factory to check for excessive vibration, for leaks in piping or seals, and for correct operation of control system and any auxiliary equipment, and for motor load through the pump curve range.

The pump suction and discharge lines shall be coupled to a reservoir and pump shall recirculate water under simulated service conditions.

10. INSTALLATION AND OPERATING INSTRUCTIONS:

Installation of equipment shall be done in accordance with written instructions provided by the manufacturer in an installation and operations manual.

A manufacturer approved technician shall provide start-up services to check pump station installation(s) for proper operation, and to instruct the owner's personnel on recommended operation and maintenance procedures.

Seven (7) copies of an operation and maintenance manual giving detailed step-by-step operating, troubleshooting and maintenance procedures for all pump station components including control panel shall be provided to the Engineer. The Engineer shall provide four (4) copies to the City.

11. SPARE PARTS

The contractor shall provide the following spare parts for this project:

2 Spare Discharge Seal Assembly for each station.
2 Spare Tandem Mechanical Seal Assembly for each station.
2 Spare Grinder Assemblies for each station.
1 Spare Mercury Float Switch and Conductor for each station.
1 Spare Alternator Relay for each station.

12. GUARANTY:

The contractor and manufacturer of this equipment shall provide to the city a one (1) year guarantee from the date of acceptance, for parts and labor to correct any material or installation problems.

13. ELECTRIC SERVICE:

Between the utility company meter and the station control panel, the contractor shall install a double throw switch unless a auxiliary power supply is provided. The double throw switch shall be mounted on a uni-strut frame on the utility company service pole or on an acceptable rack near the station. Mounted to the double throw switch shall be a Meltric Brand, 100 amp appliance inlet to match the city's portable electric generator connection plug. Power surge and lightning protection shall provided.

14. FENCING:

The design shall provide for the contractor to furnish and install 6 ft. high chain link fencing and gate. All chain link fencing and installation shall be in accordance with the "Chain Link Fence Manufacturer's Institute" specifications.

The contractor shall furnish and install a 6 ft. high chain link fence and gate as noted on the plans. Line posts shall be set at intervals not to exceed 10 ft. Where conditions require, a shorter spacing shall be used. All posts shall be set true and plumb with the post holes backfilled with 2000 psi (4 sack mix) concrete to finish grade. Line post holes shall be 12" diameter, 38" deep with 36" concrete embedment. The fence fabric shall be stretched taut approximately 2" above the ground securely fastened to the posts and top rails. Stretcher bars shall be fastened to corner posts at 15" intervals. Fabric shall be fastened to line post at 15" intervals using tie wire, metal bands, or other approved methods. The top edge shall be fastened to the top rail at 24" intervals. Fabric splicing shall be done by weaving a single strand into the ends of rolls to form a continuous mesh. Where required, the top rails shall be bent to form a radius. Bending shall be done such that the zinc coating is not damaged.

The fence fabric shall be a 2" x 2" mesh installed using standard line post, corner post, railing, hardware, and bracing. Fence fabric shall be 9 ga. steel wire with zinc-coating by the hot-dip or electrolytic process. Fabric shall be knuckled on the bottom and twisting and barbing at the top

Corner, end, and pull posts shall be standard round 2.875" O.D., 5.79 lb/ft., zinc-coated. Gate posts shall be standard round 4.00" O.D., 9.1 lb/ft., zinc-coated. Line posts shall be standard round 1.90" O.D.,2.72 lb/ft., zinc-coated. Top rails shall be standard round 1.66" O.D., 1.806 lb/ft., 18 ft. lengths with coupling connection, zinc-coated.

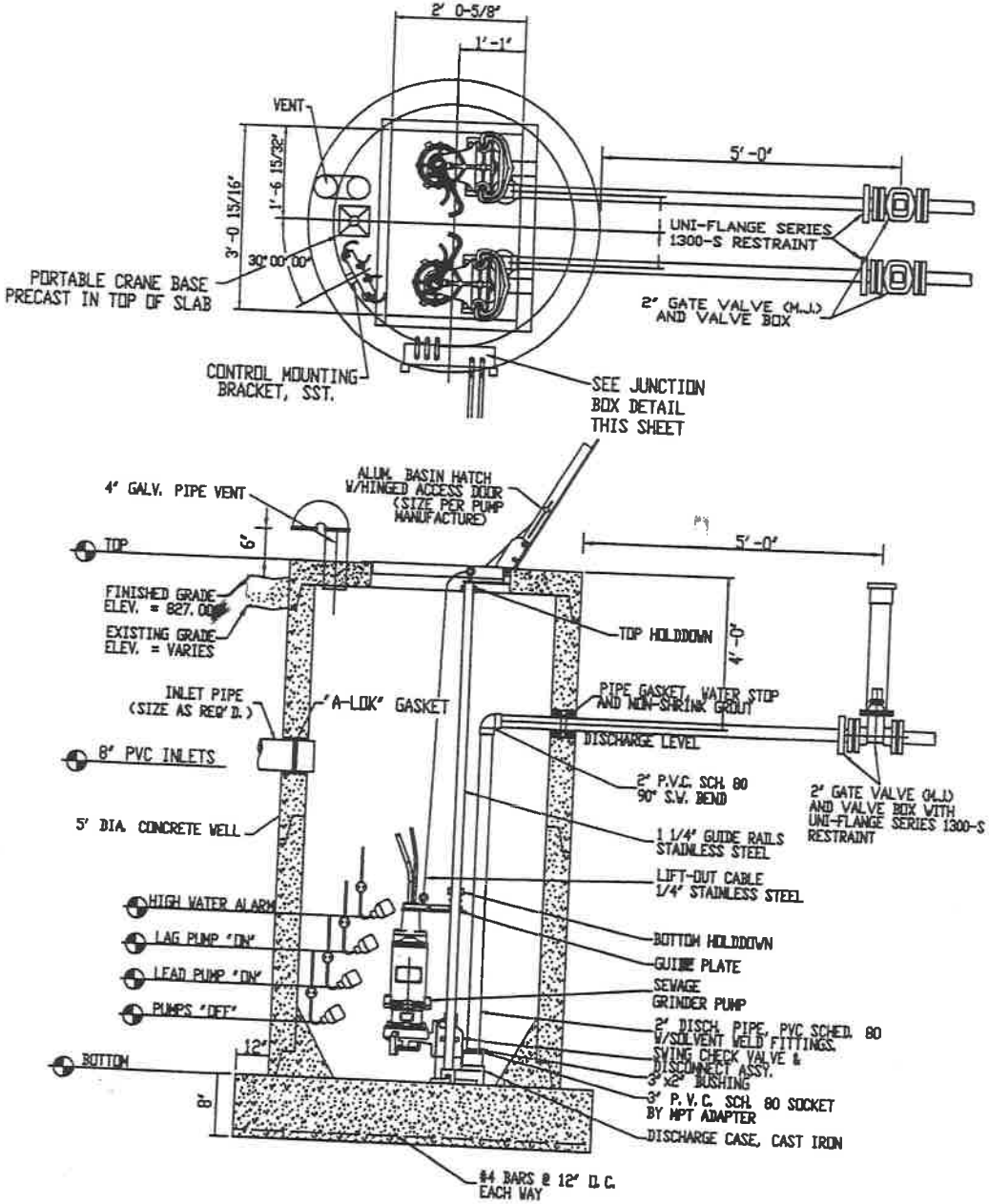
Gates shall be swing type complete with latches, stops, keepers, hinges with provisions for three (3) strands of barbed wire above the fabric. Gate frames shall be constructed of tubular members, welded at all corners or assembled with fittings. Welds shall be painted with aluminum based or zinc based paint. Frame members shall be 1.90" O.D., 2.72 lb/ft., zinc-coated. Gates shall be braced as required for the installation. Fabric shall be the same as for fencing.

Three (3) strands of barbed-wire shall be installed above the fence fabric on support arms. Barbed wire shall be 12 ga. wire, 14 ga. 4 point barbs, at 5" intervals and zinc-coated.

Hardware shall include corner post top, line post top piece with hole for rail, stretcher bars, bands, ties, or clips and other items required for a complete installation.

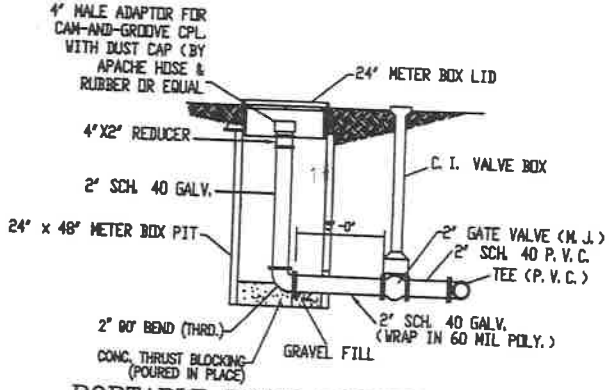
15. PUMPING STATION DRAWINGS:

The attached drawings are made part of this specification.



DUPLEX GRINDER PUMP STATION

NO SCALE (SOME ITEMS ROTATED FOR CLARITY)



PORTABLE PUMP CONNECTION DETAIL

NO SCALE

FILE: DPWSP 6-25-03

SECTION XI

SIMPLEX GRINDER PUMP STATION

SPECIFICATION

1. Scope of Work
2. Performance Requirements
3. Manufacturers
4. Construction
   - A. Pump(s)
   - B. Motor(s)
5. Electrical
6. Pump Chamber
7. Access Frame and Cover
8. Guide Rail System
9. Factory Tests
10. Installation and Operating Instructions
11. Spare Parts
12. Guaranty
13. Pump Station Drawings

SPECIFICATIONS

FOR

SIMPLEX SUBMERSIBLE GRINDER PUMP STATION

1. SCOPE OF WORK:

Under this specification, the contractor shall furnish and install simplex submersible automatic grinder pumping station(s) including all equipment and appurtenances as shown in the plans and approved shop drawings.

The principal items of equipment shall include a close coupled, submersible motor driven, grinder sewage pump; valves and piping; guide rail system; and central panel with circuit breakers, motor starter and automatic pumping level controls.

2. PERFORMANCE REQUIREMENTS:

The pump shall be capable of delivering the rated flows of shredded sewage against the total dynamic head as shown on the plans. The maximum allowable speed is 3450 rpms,, the voltage shall be 240 volt, 1-phase, and the minimum rated horsepower of each pump motor shall be 2Hp.

The pumps shall be capable of operating throughout the range of the impeller curve without overloading the motor.

No more than two (2) homes shall be served by a simplex grinder pump station without approval of the city.

3. MANUFACTURERS:

In accordance with this specification, furnish submersible grinder pump system(s) as manufactured by Myers, and similar in design and operation to the original system pumps of this type.

4. CONSTRUCTION:

A. Pump - The pump shall be a centrifugal type grinder pump with recessed type impeller and integrally built-in grinder assembly and completely submersible motor. Pump shall be installed on a lift-out rail type system in such a way that solids are fed in an up-flow direction to the grinder impeller with no feet, rails, or other obstruction below grinder inlet.

The pump impeller shall be of the multi-vane, recessed type to provide an open unobstructed passage through the volute for the ground solids. Impeller shall be of 85-5-5-5 bronze and shall be threaded onto stainless steel shaft.

The grinder assembly shall be capable of macerating all material in normal domestic and commercial sewage including reasonable amount of foreign objects such as wood, plastics, glass, rubber, sanitary napkins, disposable diapers and the like into a fine slurry.

The grinder assembly shall consist of grinder impeller and shredding ring and shall be mounted directly below the volute passage. Grinder impeller to be threaded onto stainless steel shaft and be locked in place with screw and washer. The shredding ring shall be pressed into iron holding flange for easy removal. Flange shall be provided with tapped back-off holes so that screws can be used to push the shredding ring from housing. All grinding of solids shall be from action of the impeller against the shredding ring. Both shredding ring and impeller shall be removable from the outside without dismantling the pumps and hardened to 55-60 Rockwell C.

B. Motor - The pump motor shall be of the sealed submersible type suitable for the electric service shown on the plans. Single phase motors shall be of the capacitor start, capacitor run, type for high starting torque.

Stator winding to be of the open type with Class A insulation for operating in clean dielectric oil that lubricates bearings and seals, and cools the windings.

Motors shall have three bearings, two ball bearings to support the rotor and take radial and thrust loads and a single sleeve bearing in the seal chamber to prevent shaft deflections at the lower seal. Ball bearings shall have a B-10 life of 50,000 hours.

A heat sensor thermostat shall be attached to top end of motor winding and shall be connected in series with the magnetic contactor coil in control panel to stop motor if motor winding temperature reaches 220 degrees F. Thermostat to reset automatically when motor cools.

The motor shall be protected by a tandem mechanical seal of the double spring design operating in an oil filled cavity. Seals shall have carbon and ceramic faces Type 21 BF1C1 lapped to a flatness tolerance of one light band. Metal parts and springs shall be stainless steel. An electrode shall be mounted in the seal cavity to detect any water leakage past the lower seal. Electrodes shall be connected to an amber signal light in the control panel.

The common motor, pump and grinder shaft shall be of #416 stainless steel threaded to take pump impeller and grinder impeller.

Motor power and control cords shall be Type SO of sufficient length to suit installation. Both cords shall be potted into motor end cap with epoxy potting compound. In addition, a rubber grommet that seals both cords shall be clamped onto cord by end holding cap. Cords shall withstand a pull of 150 pounds without loosening.

C. Pump and Motor Castings - All castings shall be ASTM A-48, Class 30 cast iron with 300 Series stainless steel hardware.

All iron castings shall be pre-treated with phosphate and chromic rinse and shall be painted with high temperature baked epoxy before machining and all machined surfaces exposed to the sewage water repainted with high temperature baked epoxy.

5. ELECTRICAL CONTROLS:

The pump manufacturer shall supply a completely self-contained Simplex Control Panel to operate the pump as shown in the control wiring schematic in the plans. The control panel shall provide short circuit and overload protection for the pump motor.

All control elements shall be mounted in a NEMA 4 enclosure. The NEMA 4 enclosure shall have a separate inside hinged door to provide for mounting control switches, pilot lights, run time meter and overload reset button. Outer door of NEMA 4 enclosure shall have a hasp for padlock and a minimum of 3 draw pull type catches.

A main circuit breaker for the pump shall be mounted with the operating handles through the inside door and shall have a lock arrangement that prevents the door from being opened when breakers are in the "on" position. When breakers are off, all power shall be killed to the control elements. Circuit breakers for auxiliary circuits shall be provided.

A magnetic heavy duty contactor and manual re-set quick trip ambient compensated overload block shall be provided for the motor. Overload coil shall hold with a voltage drop up to 35%. Starter shall be full voltage, NEMA rated.

Motor start and run capacitors, and start relay for single phase motors shall be mounted in control panel.

Heat sensor thermostats in the motor shall be wired in series with the magnetic contactor coil to protect the motor against excessive heat. Thermostats shall reset automatically when motor cools.

A seal leak electrode installed in the pump seal cavity shall be connected to an amber signal light on the control panel inside door.

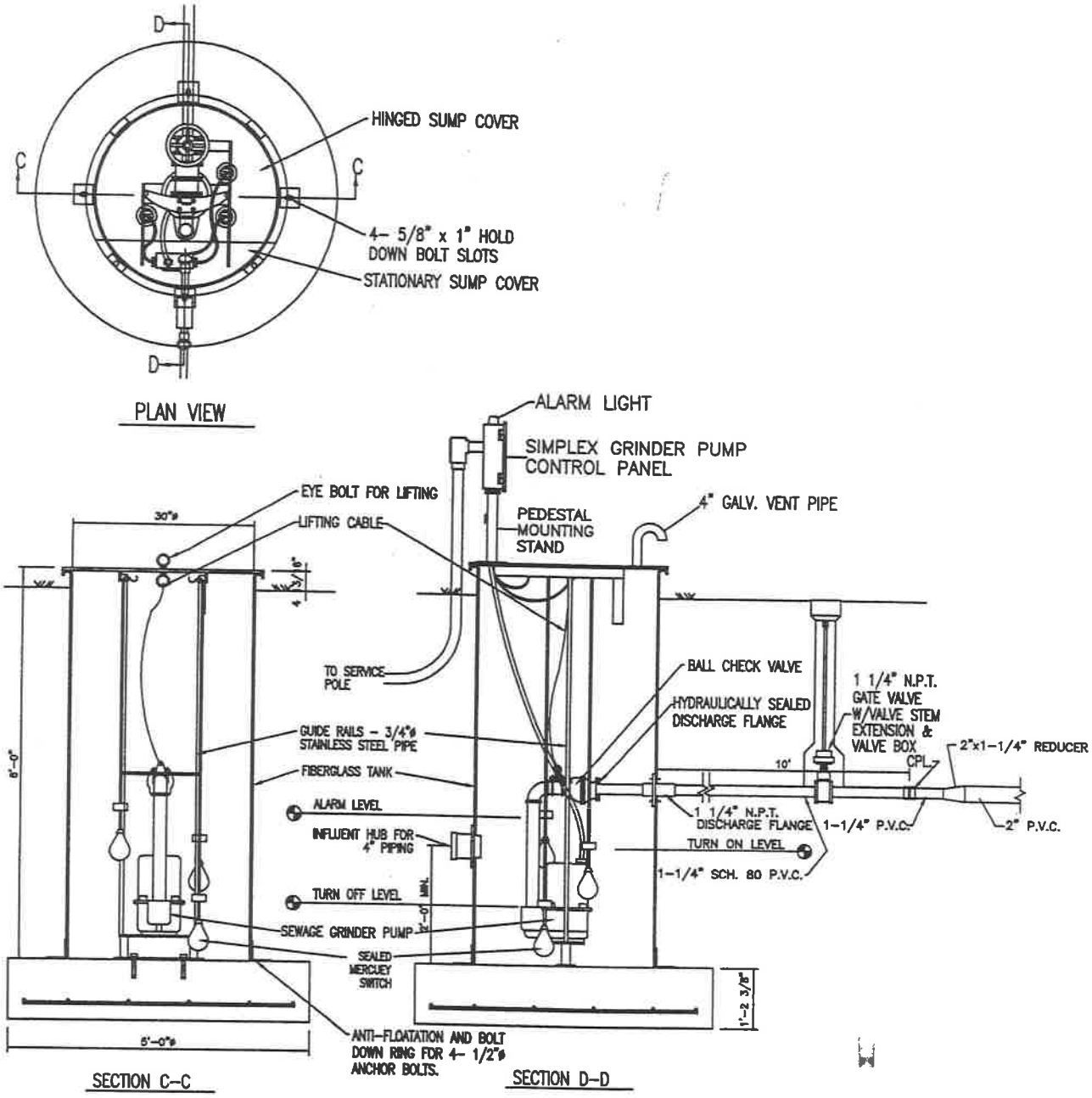
A run time meter shall be supplied for the pump to show the number of hours of operation. The meter shall be enclosed in dust and moisture-proof molded plastic case. The flush mounted dial shall register in hours and tenths of hours up to 99999.9 hours before repeating. The meter shall be suitable for operation on a 115 volt, 60 cycle power supply.

H-O-A switch, pilot lights, run-time meter and overload reset button shall be mounted on the control panel inside door. Switches shall be oil-tight construction. Toggle type switches will not be considered equal.

Sealed displacement type mercury switches shall be supplied to control pump cycling. The mercury switches shall be sealed in a solid polyurethane float for corrosion and shock resistance. Conductor cord shall be a 2-conductor stranded cord with individual insulated wires enclosed in a neoprene jacket. Cords shall be lead weighted at float end and suspended from a support bracket mounted at top of pump chamber.

A terminal strip with box type connectors shall be supplied to make all power and control connections for the pumps. A ground terminal strip shall also be provided. All terminals shall be marked for easy identification.

A high water in the wetwell alarm horn and red light (115 volt), activated by a float switch shall be provided as a part of the control panel.



SIMPLEX GRINDER PUMP WITH FIBERGLASS TANK

The pump control panel shall be completely wired at the factory, except for the power feeder lines. All wiring in the pump control panel shall be numerically or color coded as indicated on the wiring diagram. Wiring diagrams matching the unit shall be provided.

6. PUMP CHAMBER:

The Pump Chamber (wetwell) shall be a fabricated fiberglass basin. Lines shall have a flexible, water-tight, gasket connection. The minimum tank diameter shall be 30". The minimum storage volume between pump off and on shall be 50 gallons per home.

Equipment installed shall be firmly anchored so that no undue stress exists. All anchoring hardware shall be stainless steel. Shut off valves shall not be located inside the wet well. Concrete anit-floatation ring shall be installed for the chamber to rest on.

7. ACCESS FRAME AND COVER:

A pump chamber access cover shall be provided. The cover shall be structural polypropylene or aluminum. The cover shall be bolted to the basin or hinged. All hardware shall be stainless steel.

8. GUIDERAIL SYSTEM:

The lift-out rail system assembly shall permit easy removal and installation of the pump and check valve without the necessity of personnel entering the wetwell. Structural guide brackets with guide yokes of sufficient bearing strength to prevent binding shall bolt to the pump. The yokes shall mate over guide rails of a minimum of 1-1/4 inch pipe running between an upper rail support and the discharge case. A discharge nozzle or flange at the check valve shall be guided into a chamfered cavity or a sealing flange. Dual "O" rings or a resilient seal shall effect a hydraulic seal between the two parts when it is in its operating position.

The discharge case shall be securely bolted to the floor of the wetwell so that slight deflection caused by the discharge pipe will not cause the quick-connect pump flange to leak.

All cast iron parts shall be coated with corrosion resistant baked on epoxy paint.

The lift-out check valve shall be of the swing clapper type with rubber facing. A bronze seat bushing shall be mounted in face of valve to provide a corrosion-proof seat. The clapper shall be mounted on a stainless steel shaft and shall be spring loaded to prevent slamming when closing. An alternate ball-type check valve may be used with a bronze machined sealing face and a resilient ball.

The check valve shall lift out with pump to allow for inspection, cleaning or maintenance of the valve outside the wetwell. All fasteners shall be stainless steel.

An upper guide plate shall be attached to pump to support lift out fitting and guide pump on rails. A lifting eye shall be attached to plate and stainless steel cable and clevis shall be furnished for lifting pump. The pump shall be equipped with a 3/16" (min) stainless steel lifting cable with provisions for direct connection to the portable crane winch drum allowing continuous lifting of the drum.

A hold-down bracket shall be provided to prevent pump and seal fitting from rising on rails.

Guide rails shall be 1-1/4" stainless steel pipe and hold-down pipe shall be 1/2" stainless steel pipe.

Rail support and mounting bushing shall be mounted to basin wall and shall not be attached to basin cover or cover frame.

Guide rail support shall be adjustable so that perfect vertical alignment of the rails can be obtained.

9. FACTORY TESTS:

Both submersible pumps and the control panel shall be given an operational test of all equipment at the factory to check for excessive vibration, for leaks in piping or seals, and for correct operation of control system and any auxiliary equipment, and for motor load through the pump curve range.

The pump suction and discharge lines shall be coupled to a reservoir and pump shall recirculate water under simulated service conditions.

10. INSTALLATION AND OPERATING INSTRUCTIONS:

Installation of equipment shall be done in accordance with written instructions provided by the manufacturer in an installation and operations manual.

A manufacturer approved technician shall provide start-up services to check pump station installation(s) for proper operation, and to instruct the owner's personnel on recommended operation and maintenance procedures.

Seven (7) copies of an operation and maintenance manual giving detailed step-by-step operating, troubleshooting and maintenance procedures for all pump station components including control panel shall be provided to the Engineer. The Engineer shall provide four (4) copies to the City.

11. SPARE PARTS

The contractor shall provide the following spare parts for this project:

1 Spare Pump and Motor (If more than 10 units, one space pump unit for each 10 unit increment)
1 Spare Discharge Seal Assembly for every 10 units.
1 Spare Tandem Mechanical Seal Assembly for every 10 units.
1 Spare Grinder Assembly for every 10 units.
1 Spare Mercury Float Switch and Conductor for every 10 units.

12. GUARANTY:

The contractor and manufacturer of this equipment shall provide to the City a one (1) year guarantee from the date of acceptance for parts and labor to correct any material or installation problem.

13. PUMP STATION DRAWINGS:

The attached drawings are made a part of this specification.

SECTION XII

AUXILIARY POWER SUPPLY

SPECIFICATION

1. General
2. Submittals
3. Quality Assurance
4. Gasoline Engine - Generator Set
5. Automatic Transfer Switch
6. Installation
7. Field Testing
8. Guarantee

AUXILIARY POWER SUPPLY

1. General

   A. This Section covers equipment, material and service requirements for furnishing, installing, and acceptance testing pre-assembled emergency/standby electric generating system including all devices and equipment specified herein, as shown on the drawings, or required for the service. Equipment shall be new, factory tested, and delivered ready for installation.

   B. References:

      1. National Electrical Code (NEC).
      2. National Fire Protection Association (NFPA).
      3. National Electrical Manufacturers Association (NEMA).
      4. Underwriter's Laboratories, Inc.

2. Submittals

   A. Furnish manufacturer's catalog data and illustrations showing principal dimensions, parts and materials for generator set, transfer switch and specified accessories. Include technical data and specifications for major components.
   B. Furnish sizing calculations verifying generator set selection.
   C. Furnish interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
   D. Furnish installation instructions and drawings showing layout and anchorage of equipment and appurtenances.
   E. Furnish operating instructions and service manuals for the specific equipment furnished.

3. Quality Assurance

   A. Manufacturer shall be experienced in the design and production of engine generator sets, automatic transfer switches and associated controls for a minimum of 5 years.
   B. Engine generator set, automatic transfer switch and all specified accessories shall be provided by a single source of supply and responsibility.

4. Gasoline Engine - Generator Set

   A. Acceptable Manufacturers:

      1. Onan Corporation. (To match existing portable generator set manufacturers.)

   B. Provide 4-cycle, 1800 RPM, gasoline engine-driven generator set with low reactance brushless generator, torque-matched excitation, automatic voltage regulator, set-mounted control panel, and high ambient cooling system.

      1. Unit rating: Generator set shall be rated for continuous standby operation, 120/240 volt, 3-phase, 4-wire, 60 hertz at 0.8 power factor.

2. Size unit to start and carry the connected loads indicated on the drawings.
3. Equip set with associated control equipment to provide automatic starting and stopping of engine-generator and switching of load.

C. Gasoline Engine: Engine shall be 4 cycle, 1800 RPM, inline 6 or V-6, or V-8.

1. Equip engine with mechanical governor, integral with fuel pump, to provide automatic engine-generator set frequency regulation of 5% from steady state no load to steady state rated load.
2. Provide unit-mounted closed loop radiator system to properly cool the engine when generator set is delivering full rated load with 122° F. inlet air. Guard rotating parts from accidental contact.
3. Equip engine with low oil pressure, high water temperature, over-crank and automatic overspeed shutdown devices.
4. Include the following engine accessories:

    a. Electric starter capable of three complete cranking attempts without overheating.
    b. Positive displacement, mechanical, full pressure, lubrication oil pump. Full flow lubrication oil filters with replaceable spin-on cannister elements, dipstick oil level indicator and oil drain.
    c. LP liquid gas fuel system shall be provided, including converter. Contractor to secure a licensed LP installer to provide a 500 gallon tank and the required fuel line between the tank and engine. Fuel line to be buried and inside of 2" Sch. 40 PVC pipe.
    d. Replaceable dry element air cleaner for heavy duty application.
    e. Engine mounted battery charging alternator with solid-state voltage regulator.

D. AC Generator:

1. Shall be synchronous, four pole, revolving field, drip-proof construction, single pre-lubricated bearing, air-cooled by a direct drive centrifugal blower fan, and directly connected to the engine with semi-flexible steel disc coupling.
2. All insulation system components shall meet NEMA MG1 standard temperature limits for Class F insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105° C.
3. Equip generator with excitation system and voltage regulator to maintain voltage within 2% of rated value for any constant load between no load and rated load.
4. Provide unit capable of voltage recovery within three seconds and with a maximum voltage dip of 20% following application of any load up to 100% of rated load at rated power factor.

E. Engine-Generator Set Control:

1. Control Logic:

    a. Control system shall provide for automatic starting and stopping of engine-generator and switching of load.
    b. Control shall include automatic remote start capability from a panel mounted 3-position (Stop, Run, Remote) switch.

c. Control shall shut down and lock out upon failing to start (overcrank), overspeed, low oil pressure, high engine temperature or operation of a remote manual stop station.
d. Provide alarm indicating lights for the following conditions:

1) Overcrank shut down - red
2) Overspeed shut down - red
3) Low oil pressure shut down - red
4) Low oil pressure pre-alarm - yellow
5) High engine temperature shut down - red
6) High engine temperature pre-alarm - yellow
7) Low coolant temperature - yellow
8) Run - green
9) Not in automatic start - flashing red

2. Control Panel Enclosure:

a. Shall be NEMA 3R steel enclosure mounted on the generator set with vibration isolators.
b. Equip panel with the following devices and features:

1) Control panel illumination lamp with on/off switch.
2) Engine oil pressure gauge.
3) Coolant temperature gauge.
4) DC voltmeter.
5) Running time meter (hours).
6) AC meter package with combination ammeter-voltmeter-phase selector switch.

F. Base:

1. Mount engine-generator set on a heavy steel base to maintain alignment between components. Cushion mount with pad-type vibration isolators.
2. Include battery tray with battery holddown clamps.
3. Base shall receive a baked enamel finish to match generator set.

G. Fuel Storage Tank:

1. Provide a 500 gallon LP tank.
2. Provide poured concrete pad for leveling and load bearing.

H. Generator Set Auxiliary Equipment and Accessories:

1. Housing: Provide corrosion resistant weather protective housing constructed of rugged steel and factory-assembled to generator set base and radiator cowling.

a. Housing shall permit ample airflows for generator set cooling.
b. Equip with lockable, hinged access doors to permit access to service points and controls.
c. Housing shall be cleaned, phosphated and painted inside and out with rust inhibiting primer and finish coat of manufacturer's standard color.

2. Circuit Breaker: Provide properly sized and rated, UL listed, molded case, thermal-magnetic type, 3-pole circuit breaker as a load circuit interrupting and protection device.

    a. Set-mounted and wired.
    b. Operate both manually as an isolation switch and automatically during overload and short-circuit conditions.

3. Coolant Heater: Provide engine mounted, thermostatically controlled water jacket heater, sized as recommended by the equipment supplier.
4. Starting and Control Batteries: Provide lead acid type, 12 volt DC, sized as recommended by the generator set manufacturer. Include battery cables and connectors.
5. Battery Charger: Provide 10 Amp voltage regulated battery charger. Equip charger with float, taper and equalize charge settings. Provide visual alarm lights to indicate the following conditions:

    a. Loss of AC power - red
    b. Low battery voltage - red
    c. High battery voltage - red
    d. Power on - green

6. Exhaust Muffler: Provide residential grade muffler. Size, type and installation as recommended by the generator set manufacturer set manufacturer.

5. Automatic Transfer Switch

A. Acceptable Manufacturers:

    1. Onan Corporation.

B. Provide factory assembled transfer equipment with electronic control designed for surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts. Include quick-make, quick-break contact mechanisms for manual transfer under load.

    1. Transfer switch and accessories shall be UL listed and tested per UL Standard 1008.
    2. Ratings:

        a. Main contacts shall be rated 600 volts AC minimum.
        b. Transfer switch shall be rated to carry 100% of rated current continuously in the enclosure.
        c. Equipment shall have a withstand and closing rating in RMS symmetrical amperes greater than the available fault currents at the site.

    3. Equip transfer switch with solid-state automatic control equipment to monitor utility source and provide automatic starting and stopping of engine-driven generator set and switching of load between sources.

C. Construction:

1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in both positions.
2. Equip with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms for safe manual operation under load.
3. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position.
4. Transfer switches for 4-wire systems shall be supplied with a switched neutral pole of same construction and ratings as phase poles. All poles shall be switched simultaneously using a common crossbar.
5. Enclosure:

    a. Shall be NEMA 4X stainless steel enclosure mounted as indicated on the drawings.

        1) Equip panel with hinged access door secured with fast operating clamp assembly. Include padlock hasp on door.
        2) Provide knockouts for conduit entry. Allow for wire bending space at points of entry in accordance with NEC.
        3) Equip panel with thermostatically controlled heater to minimize effects of humidity and condensation.
        4) Controls on panel door shall be key-operated. Provide position indicator lamps and power available lamps for both sources.
        5) Manual operating handles and all control switches, other than key-operated switches shall be accessible only by opening the enclosure door.

D. Automatic Controls:

1. Provide voltage and phase monitoring system which will automatically start the standby generator and transfer the electrical load to the generator when any phase of utility line voltage drops below 75% of normal voltage, and transfer the electrical load back to the utility source when all phases are 90% or more of rated voltage.
2. Equip transfer switch with a cranking limiter to open starting circuit after 45 seconds should the engine fail to start.
3. Provide time delay features for engine starting to override momentary power dips, load retransfer and engine shutdown.
4. Voltage sensors and control relays shall be solid state plug-in type devices.
5. Equip unit with test switch for manual simulation of power outage including standby operation and load transfer.
6. Provide solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide a with/without load selector switch for the exercise period.

6. Installation

A. Install standby engine-generator unit and accessories as indicated in accordance with the equipment manufacturer's written instructions, and with recognized industry practices. Comply with NFPA and NEMA standards pertaining to installation of standby engine-generator systems and accessories.

B. Make all electrical and control connections. Tighten connectors and terminals in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A.
C. Grounding: Provide equipment grounding connections for engine-generator set as required by NEC. Tighten connections to comply with torques specified in UL Standard 486A, to assure permanent and effective ground.
D. Provide all necessary materials, components and adjustments as required for a complete and operating standby power system.
E. Provide all necessary fuel and lubrication for initial start-up, testing, and as required for successful operation.

7. Field Testing

A. Manufacturer's Services:

1. Provide equipment manufacturer's services at the jobsite to check installation, to perform initial start-up and operational test, and to instruct Owner's personnel in the proper operation and maintenance of the equipment.
2. Services to be performed by an authorized representative of the engine generator set manufacturer.

B. Operational Test:

1. Prior to acceptance, an operational test of all pumps and control systems shall be performed to determine if the installed equipment meets the purpose and intent of the specifications. Operational test shall demonstrate that the equipment is not electrically, mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms with the specified operating conditions.
2. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two-hour full load test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test as required.
3. Operational test shall include checks for excessive vibration, leaks in fuel system, correct operation of control systems and equipment, proper alignment, excessive noise levels, and power output.
4. Perform complete megger testing.
5. Make all necessary equipment adjustments and corrective work indicated by tests. Repeat testing as necessary.
6. Submit two copies of written report stating operations performed and results obtained.

8. Guarantee:

The contractor and manufacture of this equipment shall provide to the City a one (1) year guarantee from the date of acceptance, for parts and labor to correct any material or installation problems.

SECTION XIII

FORCE MAIN

SPECIFICATION

1. Scope
2. Materials
3. Delivery and Handling of Materials
4. Pipe Installation
5. Testing
6. Highway and Railroad Crossings
7. Design with Respect to Water Main
8. Portable Pump Connection
9. Detailed Drawings

SPECIFICATIONS

FOR

FORCE MAIN

1. SCOPE

a. These specifications shall apply to the installation of all pipe, fittings, and valves, included in the pumping station force main system as shown on the plans. Specific materials and sizes to be used are set forth on the plans and in the specifications.

2. MATERIALS

a. Ductile Iron Pipe and Fittings:

(1) Fittings shall be mechanical joint except where otherwise noted on the plans. All iron fittings shall conform to ANSI A21.10 (AWWA C110) with cement mortar lining. Buried fittings shall have bituminous seal coat. Restrained joints shall be provided where noted on the plans.

(2) Ductile iron pipe (D.I.P.) shall conform to ANSI A21.51 (AWWA C151) pressure Class 350 (min.) with cement mortar lining according to ANSI 21.4 (AWWA C104) and bituminous seal coat.

(3) The joint material for ductile iron pipe shall conform to ANSI A21.11 (AWWA C111) for push-on-joint. Flanged or mechanical joints shall be used where specifically noted on the plans.

(4) Mechanical joint bolts and nuts shall be of the best quality, high strength, heat treated cast iron and shall have standard hex nuts and tee heads. Flange bolts and nuts shall be best quality milled steel with standard hex nuts and heads. All bolts shall be proper size and length to suit details.

(5) The manufacture shall provide as "shop drawings" a certification indicating compliance with the material specification and details for installation to the Engineer. The Engineer shall provide the City with an approved copy.

b. PVC Plastic Pipe:

(1) The PVC pipe shall conform to PVC 1120 pressure pipe as made from Class 12454-B material, as defined in ASTM D1784, providing a hydrostatic design basis of 2000 psi and meeting all requirements of ASTM D-2241.

(2) The PVC pipe shall have a pressure Class rating of 200 psi and a SDR ratio of 21.

(3) The pipe shall be manufactured using an integral wall-thickened bell end and an elastomeric-gasket, conforming to ASTM D2672 (Bell-End) and ASTM F477 (Gasket).

(4) The pipe shall bear the National Sanitation Foundation (NSF) Seal of approval in addition to the marking requirements of ASTM D- 2241.

(5) The pipe shall be tapered to allow ease of joint make-up. The manufacturer recommended joint lubricant shall be used.

(6) The joint shall have a marking on the pipe that will indicate when the pipe is accurately positioned within the joint. The pipe joint shall also permit the thermal expansion or contraction of the pipe.

(7) For cast iron fittings to PVC pipe the joint shall be mechanical joint in cast iron fittings with required transition materials.

(8) The manufacturer shall provide as "Shop drawings" a certification indicating compliance with the material specification and details for installation to the Engineer. The Engineer shall provide the city with an approved copy.

c. Marking Tape

(1) A detectable marking tape, APWA color coded for sewage force main (brown), with wording similar to "Caution Force Main Buried Below" permanently printed on a 3" wide, 5 mil thick film, shall be installed 6" above the force main pipe.

(2) The tape shall consist of 35 gauge solid aluminum foil core, and laminated with two layers of clear plastic film. The tensile strength shall be a minimum of 28 lbs./inch (5,600 psi) bond strength shall be five hours without peeling in boiling water, the flexibility shall be pliable hand per ASTM 671. Printing shall be black letter and be permanent. Standard roll lengths of 1,000 feet shall be used.

(3) The manufacturers shall be equal to PRO-LINE SAFETY PRODUCTS.

3. DELIVERY AND HANDLING OF MATERIALS

a. All materials shall be carefully inspected for damage in transit and if such be found, same shall not be unloaded except upon the instruction from the official freight agent.

b. All pipe fittings, valves, and other accessories shall be unloaded by the use of hoist of skidways. Same shall be handled in such manner as to avoid damage due to shock. Under no circumstances shall pipe be dropped to the ground from the cars or trucks.

4. PIPE INSTALLATION

a. General: Competent men shall be employed and suitable equipment necessary for the execution of work if required.

The pipe and fittings shall be lowered in the trench piece by piece, by means of ropes or suitable equipment. Under no circumstances shall pipe or other materials be dropped or dumped into the trench.

b. Trench Excavation:

(1) Excavated trenches shall be cut to the alignment as set by the Engineer's stakes and with sufficient width that the pipe may be efficiently installed and to a depth to provide no less than 42" of cover over the top of the pipe, except where solid is encountered. A greater depth may be required to obtain an 18" clearance with potable water lines or as required by the plans. In trenches with sold rock, the minimum cover may be reduced to 30" except for water main crossings.

Trenches shall be cut as deep as necessary on either side of natural depressions, ditches, waterways, etc., to provide the required cover over the low spot. Excessive change in gradient shall not be allowed unless fittings are used. Common trenching with a gravity sewer may be used.

(2) Trenches shall not be cut too far ahead of laying operations and according to the Engineer's instructions.

(3) The pipe and fittings shall be installed using only the methods recommended by the manufacturer.

(4) The trench shall be excavated to depth sufficient to obtain the required cover plus a minimum of 4" of crushed stone bedding material.

(5) Top soil in areas other than roadways shall be separated and used to finish the backfill.

c. Solid Rock Excavation

(1) Solid rock shall be defined as such material that cannot be excavated without drilling and blasting, wedging, sledging, or barring. Stones, boulders, or underground concrete segments, ten (10) cu. ft. in volume or greater, shall be classified as solid rock.

d. Pipe Laying:

(1) A thorough cleaning of the pipe shall be done just before the pipe is lowered into the trench. Before lowering the pipe it shall be inspected for defects. Defective or damaged pipe shall not be installed.

(2) Joints shall be prepared and made according to the manufacturer's recommendations.

(3) On all pipe lines two (2) inches in diameter and larger, all changes in alignment exceeding twenty-two and one-half (22-1/2°) degrees shall be squarely anchored by suitable thrust concrete backing. Such concrete backing shall be so spaced that the pipe or fitting joints will be accessible for repair. The area of the bearing on the pipe and the ground in each instance shall be determined by the Engineer.

(4) Prior to backfilling all pipe and fittings shall be inspected and approved by the Engineer and the City.

e. Trenching, Backfill, and Cleanup:

(1) The bottom of the trench shall be backfilled with crushed rock sand bedding material. Bedding material shall be deposited in the trench simultaneously on both sides of the pipe and to elevations of at least 6" above the top of the pipe. Bedding rock shall have the following gradation:

Percent Passing	Sieve Size
100	3/8"
95-100	No. 4

(2) The upper portion of the trench may be backfilled with materials containing coarser material and may be compacted by hand tamping or flooding (trench jetting). At street crossings, the entire depth of the backfill shall be crushed rock.

(3) Upon completing the backfill of the trenches, and prior to seeding or pavement replacement, same shall be maintained in a safe condition relative to transportation. The ditches shall be maintained for the period of the contract in such manner that no standing water will occur over the trenches. All excess excavation materials and equipment shall be moved from the alignment of the trench and disposed of at the direction of the Engineer.

(4) Before proceeding with construction operations, contractor shall furnish and install suitable, substantial gate or gap in every fence at intersection with right-of-way for access to land crossed by the line and for passage of construction equipment. Fences shall be reinforced as necessary to prevent damage. Contractor will replace fences to their principal location and condition upon completion of the line segment. Contractor shall be responsible for keeping gates closed at all times during performance of work, shall prevent livestock from entering or leaving properties. Contractor shall be responsible for any damage caused by improperly installed gates.

(5) Unless otherwise specified, all disturbed lawn, parkway and other vegetated areas shall be graded and seeded as follows.

After the trench backfill has been compacted, the excavated area shall be covered with at least 2" of top soil free of rock larger than 1" in largest dimension and noxious weeds or seeds. Before final raking, areas to be seeded shall be fertilized with a mixture containing 12 lbs. each of soluble nitrogen, phosphoric acid and potash per 100 lbs. by spreading evenly at the rate of 12 lbs. per 1,000 sq. ft. of area using a mechanical spreader of the rotary type. Lime shall be added at a minimum rate of 1,000 lbs./acre or to a soil pH of 6.0. The area shall then be raked to a smooth even surface, the soil loosened to a depth of at least 1" and seeded.

The seed mixture shall be the type of grass that exists in that location. In those areas where the variety of grass cannot be determined, the seed mixture for maintained lawn areas shall be as follows and shall be evenly distributed over the area at the rate of 6-8 pounds per 1000 square feet using a mechanical seeder. No seed or mulch shall be placed until the engineer accepts the grade and seedbed.

Variety	Mixture	Purity	Germination
Turf Type Tall Fescue	100%	95%	90%

The following seed mixture shall be used in all other areas such as fields, pastures, roadside ditches, etc. where the existing variety cannot be determined, and shall be evenly distributed over the area at the rate of 45 pounds per acre (1 pound per 1000 square feet) using a mechanical seeder.

Variety	Mixture	Purity	Germination
Kentucky 31 Fescue	90%	95%	90%
Annual Rye Grass	10%	98%	90%

All seed shall be free from Johnson grass, Canadian thistle or field bindweed seed and contain less than 2% of other weed seed, and shall be from the previous years seed crop.

All reseeded areas shall receive straw mulch at a rate not less than 2-1/2 ton per acre (100 pounds per 1000 square feet).

Sod shall be provided where specifically noted on the plans.

At the City's discretion, problem erosion areas shall be provided with temporary cover consisting of annual rye grass and excelsior blanket until permanent cover can be established.

Reseeding of disturbed areas shall be accomplished as the construction work progresses, during the next available Spring or Fall seeding period. Unless authorized by the Engineer, no seeding shall take place from November 1 through April 1 and from June 1 through August 15.

All shrubs, bushes, and small trees that are removed during construction shall be replaced to their original conditions or otherwise disposed of as called for on the plans or as designated by the Engineer.

The contractor shall guarantee a stand of grass and shall protect all landscaping work against damage until completion and final acceptance of the work.

f. Pavement Repair:

(1) All pavement which has been removed during the course of construction or which, in the opinion of the City, has been damaged during the progress of the work, shall be replaced with the type of material noted on the plans or if not specified on the plans, the material shall be of the same type as the original paving. The required repairs shall be made by the contractor for damage to roadways resulting from construction or the contractor's use during construction.

(2) Prior to placing the final roadway surfacing the top 6" of backfill shall be further compacted to obtain at least 95% of maximum density.

(3) Following a sufficient "weathering" period approved by the Engineer, the Contractor shall make the final pavement repairs. Final pavement repairs shall include addition of base materials, grading and compacting of the base to obtain the specified quantities, roadway cross-section and alignment prior to placing the road surfacing. The specified roadway surfacing shall be placed following approval by the Engineer of the subgrade and base. All work and materials shall be in accordance with the latest edition of the "Missouri Standard Specifications for Highway Construction" as published by the Missouri State Highway Commission and as noted in the plans.

g. Public Convenience: Contractor shall conduct the work at all times so as to cause no more obstruction or inconvenience to the public than is deemed necessary by the City. Free passage for vehicles shall be maintained along roadways, and drives, where it is practical to do so. Where free passage of vehicles is not possible in the opinion of the City, the Contractor may arrange for the diversion of traffic or closing of roadways, as hereinafter provided. Free access shall be provided to all fire hydrants, water and gas valves, and fire alarm or police call boxes, or other emergency devices.

When it becomes necessary to close any roadway the contractor shall notify the City at least 48 hours in advance of such closure including information as to the exact location and extent, the time and expected duration and the reason for the closure. If, in case of an emergency, it becomes necessary to close any street without advance notice, the contractor shall immediately notify the Police and Fire Department and advise the City of such closure at the earliest opportunity.

The contractor shall provide for a sufficient number of warning lights, signs, and barricades to be available on the work and shall cause them to be placed in such numbers and at such locations as required to maintain reasonable safety to pedestrians and vehicular traffic. When it becomes necessary to divert traffic, a detour route shall be selected by the City and the contractor shall place directional signs of such nature and in sufficient numbers to clearly define the detour route. Barricades, lights and warning signs shall be constructed in accordance with Section 20 of the Manual of Accident Prevention in Construction published by the Associated General Contractors of America or as otherwise approved by the Engineer. Warning lights shall be lighted from sunset to sunrise. The contractor is solely responsible for safety and shall comply with all federal, state, and local laws pertaining to safety.

5. TESTING

(a) All completed pipelines shall be tested for both structural strength and for water leakage.

(b) Pressure Test: Each pipe line section to be tested shall be subjected to a hydrostatic pressure of at least 1.5 time the actual working pressure at the point of testing and not less than 1.25 times the working pressure at the highest point along the test section and a minimum of 100 psi. Test pressures shall be of at least 2-hours duration and not vary by more than $\pm$ 5 psi for the duration of the test.

Each pipe line section to be tested shall be filled slowly with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. Before applying the specified test pressure, air shall be completely expelled from the pipe line.

Any exposed pipe, fittings and joints shall be carefully examined during the test. Any damaged or defective pipe or fittings that are discovered shall be repaired or replaced with sound material and the test repeated until the pipe line is satisfactory to the Engineer and City.

The contractor shall provide all temporary equipment including valve, blocking, to perform the test.

(c) Leakage Test (Pressure Pipe) : A leakage test shall be conducted concurrently with the pressure test. Leakage is defined as the quantity of water that must be supplied into the pipe line section being tested to maintain the test pressure within $\pm$ 5 psi of the specified test pressure. No pipe line installation will be accepted if the measured leakage is greater than that determined by the following formula:

$$L = \frac{S \times D \times P^{1/2}}{133{,}200}$$

in which L is the allowable leakage in gallons per hour; S is the length of the pipe line tested in feet; D is the nominal diameter of the pipe in inches; and P is the average test pressure during the leakage test in pounds per square inch gauge.

If any test discloses leakage greater than that determined by the above formula, the contractor shall, at his own expense, locate and make repairs as necessary until the leakage is within the specified allowance.

All visible leaks shall be repaired regardless of the amount of leakage.

6. HIGHWAY CROSSINGS

a. The contractor shall make highway crossings where shown on the plans. The contractor shall pay fees and obtain permits for the crossings and shall comply with all requirements of the Highway Dept. If the Highway Dept. requires that the line be tunneled or bored through, the contractor shall furnish all pipe, pipe encasement, tunneling, boring equipment, timbering, shoring, bracing, rock excavation and other labor material required and shall receive no additional payment for extra items involved. Casing pipe and carrier pipe shall be installed in accordance with the Highway Dept. and the American Railway Engineering Association Pipe Line Specifications, Part 5.

b. Casing Pipe: Casing pipe and joints shall be constructed from steel, having a minimum yield strength of 35,000 psi. Joints shall be leak-proof by welding.

(1) Pipes under Highway crossing shall have the following wall thickness: 16" and under, 0.188"; 18", 20" and 22", 0.250".

c. Carrier Pipe Installation: The carrier pipe shall be placed in the casing using manufactured 14 gauge S.S. band and high density polymer runner casing spacers, 3 per pipe section or a 6 foot maximum spacing, or mechanically locked in place high density polyethylene. Concrete cradle shall be placed with the pipe where it enters and leaves the casing. Bore pits shall be backfilled with crushed rock up to the bottom of the pipe to provide a firm support and prevent settlement and damage to the pipe.

7. DESIGN WITH RESPECT TO WATER MAINS

a. Horizontal Separation: Whenever possible, force mains should be laid at least 10 feet, horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a force main may be laid closer than 10 feet to a water main if;

(1) It is laid in a separate trench, or if

(2) It is laid in the same trench with the water mains located at one side on a bench of undisturbed earth, and if

(3) In either case the elevation of the top (crown) of the force main is at least 18" below the bottom (invert) of the water main.

b. Vertical Separation: Whenever force mains must cross under water mains, the force main shall be laid at such an elevation that the top of the force main is at least 18" below the bottom of the water main. When the elevation of the force mains cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical joint type pipe for a distance of 10 feet on each side of the force main so that both joints will be as far from the force mains as possible.

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both the water main and force main should be constructed of mechanical joint cast-iron and shall be pressure tested to assure watertightness.

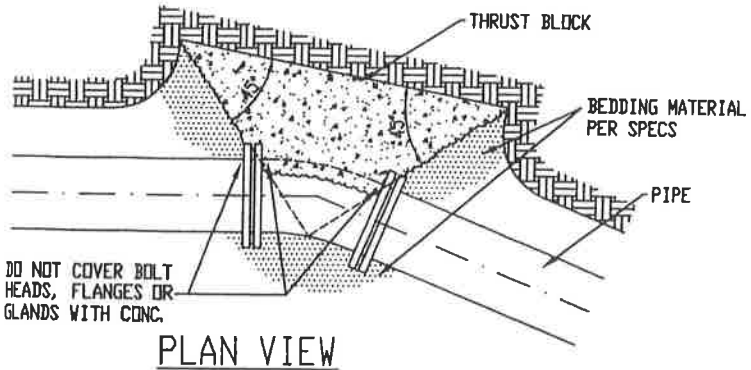
c. Water Supply Interconnections: There shall be no physical connection between a public or private potable water supply system and a force main or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable supply.

8. PORTABLE PUMP CONNECTION

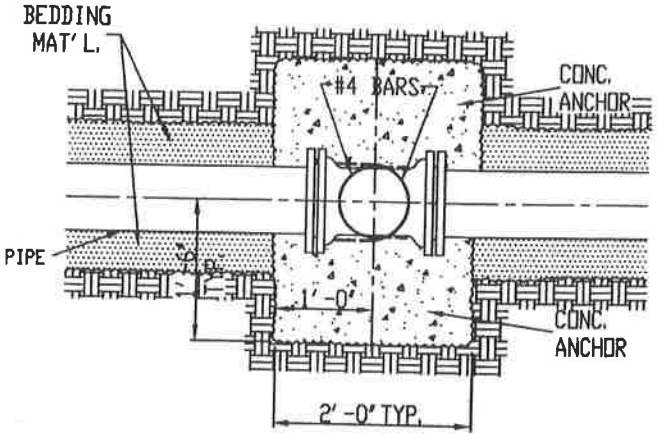
A tee fitting with a 4" branch shall be installed near the pump station. A 4" lead with a 4" resilient seat gate valve and valve box shall connect to the tee and to a 4" aluminum cam and groove quick coupling set in a 24" concrete pipe or manhole section with a manhole frame and cover. The quick coupling shall match the City's portable pump discharge hose fitting.

9. DETAILED DRAWINGS

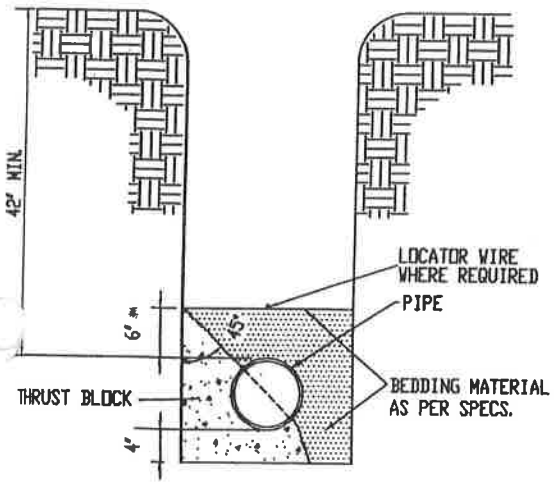
The attached drawing are made a part of this specification.



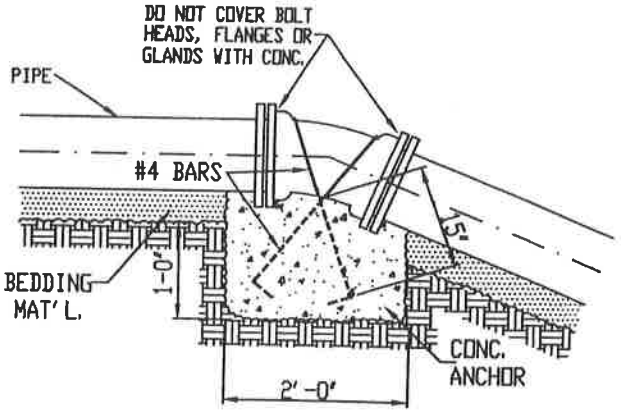
PLAN VIEW
HORIZ. BEND



PLAN VIEW
VERT. BEND



SECTION
HORIZ. BEND

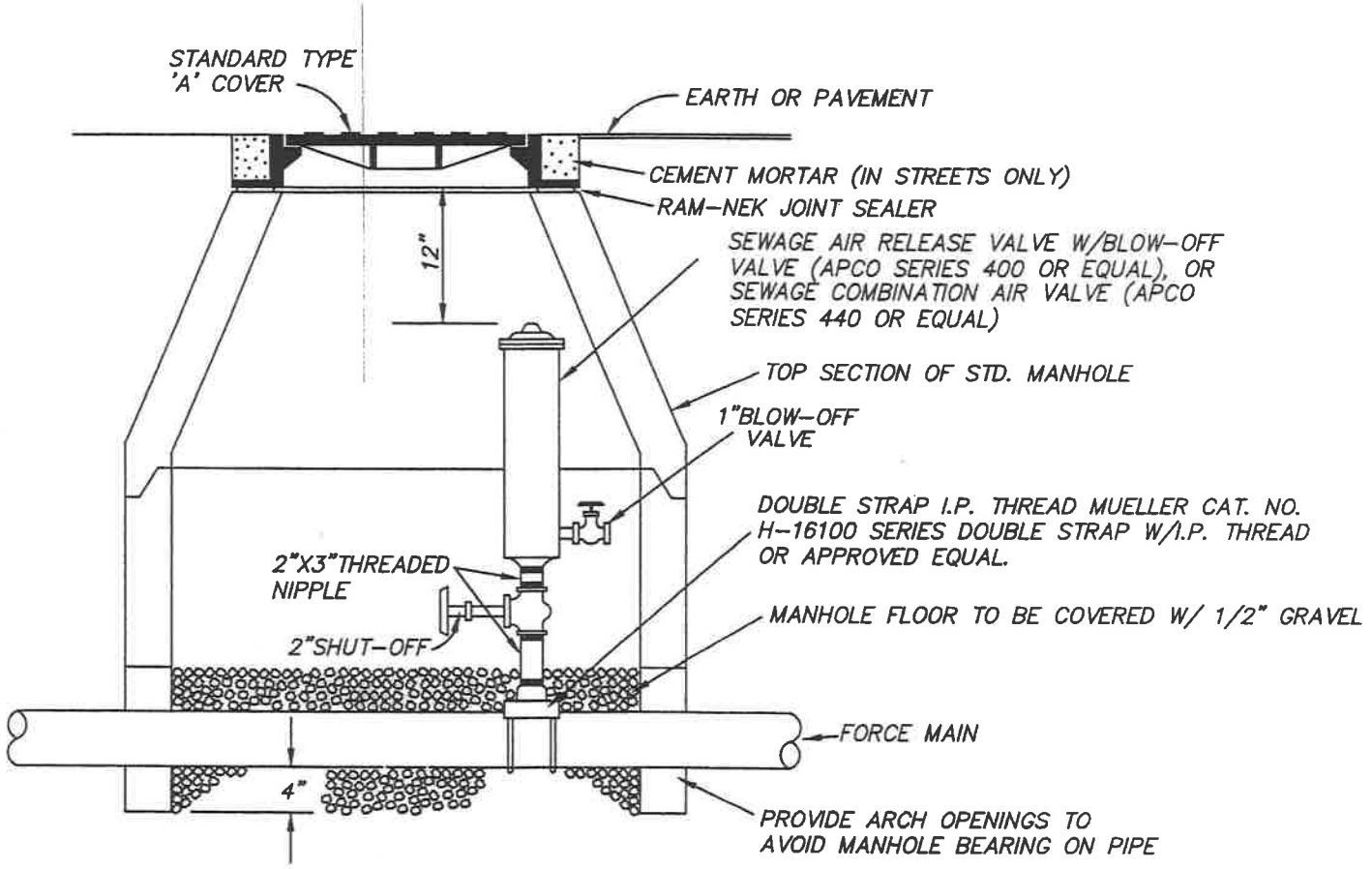


SIDE VIEW
VERTICAL BEND

BLOCK BEARING AREA				
PIPE SIZE	22 1/2°	45°	90°	'T' & VALVE OR PLUG
2"	0.2 SQ. FT.	0.3 SQ. FT.	0.4 SQ. FT.	0.3 SQ. FT.
3"	0.4 SQ. FT.	0.6 SQ. FT.	1 SQ. FT.	0.8 SQ. FT.
4"	0.5 SQ. FT.	1 SQ. FT.	2 SQ. FT.	2 SQ. FT.
6"	1 SQ. FT.	2 SQ. FT.	4 SQ. FT.	3 SQ. FT.
8"	2 SQ. FT.	3 SQ. FT.	6 SQ. FT.	4 SQ. FT.
10"	3 SQ. FT.	5 SQ. FT.	9 SQ. FT.	6 SQ. FT.

THRUST BLOCKING DETAILS

SEWER SYSTEM DETAIL



NOTE: VALVE TO BE SET TO ONE SIDE OF MANHOLE TO FACILITATE MAINTENANCE.

SEWAGE AIR VALVE

FILE: AR12 6-25-03

SEWER SYSTEM DETAIL

SECTION XIV

STREET, PARKING, AND DRAINAGE

SPECIFICATION

INDEX

SECTION XIV
STREET, PARKING & DRAINAGE
SPECIFICATION

1. CLEARING AND GRUBBING:

A. Clearing and Grubbing:

1. This work shall consist of clearing, grubbing, removing and disposing of vegetation within the limits of the right-of-way and easement area. The Design Engineer will establish right-of-way and construction lines and will designate all trees, shrubs and plants that are to remain. The contractor shall preserve without damage the vegetation designated to remain. All tree, stumps, brush and hedge not designated to remain shall be cleared, grubbed or cleared as required and shall be disposed of in an acceptable manner. Stumps and roots in cut areas shall be grubbed to the depth of not less than 12" below the finish earth grade. In embankment areas, undisturbed stumps and roots extending not more than 6" above the ground line may remain provided they are a minimum of 12" below the finished earth grade or the slope of the embankment except in areas to be excavated. Stump holes shall be backfilled with suitable material and compacted to the approximate density of the adjacent area. In lieu of grubbing stumps outside the slop limits, stumps may be cut off not more than 3" above the ground. Grubbing or borrow areas, channel changes and inlet and outlet easements will be required only to the extent necessitated by the proposed construction.

B. Roadway, Drainage, Excavation, Embankment and Compaction:

1. This work consists of excavation, disposal or compaction of all materials encountered in the limits of the work. This work shall be performed in accordance with the specifications and in conformance with the lines, grades, thickness, and typical cross sections as shown on plans or established by the engineer.
2. Grading, excavation and backfilling for roadways, roadway intersections, sidewalks, shoulders, and parkways shall be made to the lines, grades, and cross-sections shown on the plans. During construction, the area shall be maintained in such condition that it will be well drained at all times.
3. Waste materials including organic material, trees, stumps, rubbish, and debris shall be removed from the site and disposed of as an incidental part of the grading work. Excess excavation material including muck, topsoil, and rocks larger than twenty-four (24) inches, maximum dimension, shall be considered as part of the grading.
4. Excavation: All suitable material removed by excavation shall be used as far as practicable in the formation of embankments as required to complete the work. The contractor shall sort all excavated material and stockpile when necessary, so as to provide suitable materials for embankments.
5. Embankments: The embankments shall be formed with suitable materials, as herein defined, procured from excavations made on the project site, or from borrow pits as required to complete the grading work.

a. Starting the Embankment: Where embankments, regardless of height, are placed against hillsides or existing embankments, either of which have a slope steeper than one (1) vertical to six (6) horizontal, the existing slope shall be benched or stepped in approximately eighteen (18) inch rises as

the new fill is brought up in layers or lifts. Both the material bladed out and the bottom of the area cut into, as well as the embankment material being placed, shall be compacted to the required density.

The existing surface upon which embankment material is to be placed shall have all unstable and unsuitable materials, such as topsoil, peat, mulch, coal seams, disintegrated shale, rubbish, logs or stumps, and confined saturated soils, removed to the depths shown before starting the embankment work.

b. Placing Earth Embankment: Earth shall be placed in successive horizontal layers distributed uniformly over the full width of the embankment area. Each layer of material shall not exceed eight (8) inches in thickness (loose state) and shall be compacted to not less than the required density before the next layer is placed thereon. As the compaction of each layer progresses, continuous blading will be required to level the surface and to insure uniform compaction. Embankment construction shall not be performed when material contains frost, is frozen or a blanket of snow prevents proper compaction.

c. Embankment Compaction: Density and moisture requirements for embankment shall be in relation to the maximum density and optimum moisture as determined by ASTM Designation D-698.

Embankment material shall be placed with moisture content within the tolerance of the moisture range for each type of material at the specified percent of maximum density as determined by the moisture density curve.

Earth embankment, except the top six (6) inches, and the surface of the existing ground on which embankment is to be placed shall be compacted to at least 90% of the maximum density as determined above. The top six (6) inches of the embankment shall be compacted to at least 95% of the maximum density.

All the work involved in either adding moisture to, or removing moisture from embankment materials to within these moisture limits shall be considered incidental to the completion of the grading operation.

During the progress of the work, the in-place density of the embankment may be determined by ASTM Designation D1556 or D2167. The testing for compaction shall be at the expense of the Contractor for test directed by the City.

d. Excavation Undergrade: Where materials are encountered below grade which are deemed unsatisfactory by the City for use in the work, they shall be removed to the lines and grades he may order. Areas of required undergrading shall be backfilled with a material having a low plasticity index and designated by the City as suitable. Backfill material for undergrading may be from the project site.

C. Blasting Operations and Safety:

1. All blasting materials shall be stored in a safe manner and in accordance with applicable laws, ordinances and regulations.
2. Storage containers and vehicles transporting explosives shall be clearly marked "DANGEROUS EXPLOSIVES".
3. The contractor shall provide sufficient signs warning motorists and pedestrians of the blasting zone, and the need to turn off radios when electric detonators are used.
4. The contractor shall notify owners or occupants of adjacent buildings whenever blasting operations are planned.
5. A pre-blast survey of all adjoining structures which might be affected shall be made to determine conditions prior to blasting.
6. Holes shall be loaded and shots executed so as to prevent damage to any new or existing structure located adjacent to the blasting site.
7. Workmen shall be notified to take protective measures immediately prior to the detonation of any shot.
8. It shall be the contractor's sole responsibility to determine the method of operation to obtain the desired results in a safe manner.
9. A recording seismograph shall be used to monitor blasting operations.
10. Prior to beginning any blasting operation the contractor shall provide proof of insurance coverage for this of type work.

D. Construction Requirements:

1. General:

a. Prior to the beginning to excavation and embankment operations in any area, all necessary clearing, grubbing and stripping in that area shall have been performed. The excavation and embankment for roadways, intersections and entrances shall be made to the designated alignment, grade and cross section. Side slopes shall be cut or filled and finished to a reasonable smooth and uniform surface that will merge with the adjacent terrain without variation readily discernible from the road. Finishing by hand method will not be required, except that all brush, weeds, and other debris shall be removed from right-of-way. All utility cuts in roadbed shall be backfilled with compacted wet base. After installation of all utilities, grade stakes that have been disturbed shall be replaced.

2. Fieldstone:

a. All loose fieldstone within the limits of the right-of-way shall be removed before commencing the operation of finish grading and small rock and boulder resulting from the operation of subgrade shall be removed from the roadway and shall be disposed of as directed by the engineer or inspector.

2. SUBGRADE PREPARATION:

A. Construction Requirements:

1. Subgrade preparation and placement shall meet the requirements of Missouri Standard Specifications for Highway Construction, Division 200, Earthwork.

2. The subgrade shall be substantially uniform in density throughout its entire width. It shall conform to the lines, grades, and typical cross sections shown on the plans, or as established by the engineer. The subgrade shall be constructed to drain surface water to the side ditches or curbs. All ditches and curb areas shall be kept open by the contractor.

3. Prior to laying base or setting paving forms on projects where grading and paving are included as specified by the engineer or city, soft spots and unsuitable material shall be removed to a depth not to exceed 24" or as determined by the city and backfilled with approved stabilizing material.

B. Subgrade Compaction:

1. Shall consist of compacting earth subgrade that is yielding or not substantially uniform in density. This item of work shall be performed when the subgrade density, following the use of the roller, is less than required under MoDOT specifications, as referred in Item 2A, above.

3. AGGREGATE BASE COURSE:

A. The base course shall consist of Type 1 aggregate material to the thickness noted on the plans. Materials and workmanship shall conform to Section 304 and 1007, Missouri Standard Specifications for Highway Construction, latest edition. The base course shall be placed in accordance with the plans conforming to the line and grade required for proper surface replacement.

B. Construction Requirements: Immediately in advance of spreading the materials, the subgrade shall be sprinkled, if necessary, in the amount specified by the Engineer. In no case will the contractor be permitted to place the mixture or manipulate it on muddy or frozen subgrade. Also, any mixture containing frost or frozen particles shall not be placed on the subgrade or compacted.

C. Base material, any additional material required, and sufficient water to obtain the desired compaction shall be thoroughly mixed and delivered to the road as a combined product.

D. The maximum compacted thickness of any one layer shall not exceed six (6) inches. When the specified compacted depth of the base course exceeds six (6) inches, the base shall be constructed in two or more layers of approximate equal thickness.

The contractor shall be responsible for placing the correct quantity of base material on the roadbed to construct a base conforming with the contract.

E. The material shall be uniformly spread by means of a mechanical spreader equipped with a strike-off bar and capable of spreading a uniform layer of stone. A motor grader will not be acceptable for this purpose unless specifically allowed by the City. The mixture shall be spread in successive layers of such depth that when compacted, the base will have the approximate thickness specified. Each layer shall be compacted to the specified density before another layer is placed.

F. Aggregate shall be compacted to not less than standard maximum density. The standard compaction test will be made in accordance with AASHO T 99-671 Method C., replacing any material retained on the 3/4" sieve, as provided therein. Field density will be

determined in accordance with AASHO T 191-651, or T 205-64, using the total material. The volume of the test hole may be reduced as necessary to accommodate available testing equipment. During shaping and compacting operations the moisture content of the base shall be maintained at the level necessary for compaction by wetting or drying as required.

G. Compaction shall be carried to completion by means of pneumatic tired or self-propelled, smooth wheeled rollers, weight not less than 5 tons or a vibratory compactor delivering a minimum 5 ton blow per stroke. Shaping and compaction shall be carried on until a true, even uniform base course of the proper grade, cross section and density is obtained.

Final rolling on the top course of multiple course construction or the top of single course construction shall be accomplished by self- propelled, smooth wheeled roller weighing not less than five (5) tons.

H. Shaping of the completed surface of the aggregate base for flexible type surfacing shall be continued until the deviation from the required elevation does not exceed a roughly compensating maximum of 1/2 inch.

4. PRIMER:

A. This work shall consist of preparing and treating an existing surface with bituminous material in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer. Materials and workmanship shall conform to Section 408 and 1015, Missouri Standard Specifications for Highway Construction, latest edition.

B. The materials shall be applied at the rate of 0.35 gal./sq. yd. for aggregate base and 0.05 gal/sq. yd. for tack coat on existing bituminous surfaces.

5. PLANT MIX BITUMINOUS BASE:

A. This work shall consist of a mixture of aggregate, filler, and asphalt cement prepared in a stationary plant. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements, within specified tolerances, of the job-mix formula. The mixture shall be placed in one or more courses on a prepared and primed base or underlying course in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans, or established by the Engineer. Materials and workmanship shall conform to Section 301, 1002, 1004 and 1015, Missouri Standard Specifications for Highway Construction, latest edition.

B. The materials shall consist of asphaltic cement (85-100 penetration). The aggregates and composition of mixture shall be equal to the above referenced Section 301.3. A specific job mix shall be submitted to the Engineer for approval.

C. The finished thickness shall be as noted on the plans. Placement shall be by an approved spreading machine with a maximum single layer compacted thickness of 4". The mixture shall be compacted by at least three complete coverages over the entire area with either a pneumatic tired roller or a tandem type steel wheel roller weighing not less than 10 tons.

D. Surface tolerances on final riding surfaces shall not vary from a 10 foot straight edge, parallel to the centerline by more than 1/8" and shall be substantially free from waves or irregularities.

6. PLANT MIX BITUMINOUS PAVEMENT:

A. This work shall consist of a mixture of aggregate, filler, and asphalt cement prepared in a stationary plant. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements, within specified tolerances, of the job-mix formula. The mixture shall be placed in one or more courses on a prepared base or underlying course in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans, or established by the Engineer. Materials and workmanship shall conform to Section 401, 1002, and 1015, Missouri Standard Specifications for Highway Construction, latest edition.

B. The materials shall consist of asphaltic cement (85-100 penetration). The aggregates and composition of mixture shall be equal to Grade BP-2. A specific job mix shall be submitted to the Engineer and City for approval.

C. The finished thickness shall be as noted on the plans. Placement shall be by an approved spreading machine with a maximum single layer compacted thickness of 2". The mixture shall be compacted by at least three complete coverages over the entire area with either a pneumatic tired roller or a tandem type steel wheel roller weighing not less than 10 tons.

D. Surface tolerances on final riding surfaces shall not vary from a 10 foot straight edge, parallel to the centerline by more than 1/8" and shall be substantially free from waves or irregularities.

7. PORTLAND CEMENT CONCRETE PAVEMENT:

A. The work shall consist of furnishing all labor, materials, and equipment necessary to perform all operations in connection with construction of Portland Cement Concrete pavement, in accordance with the specifications and plans.

B. Materials:

1. Concrete shall be Portland Cement Concrete conforming to ASTM C-150, Type 1, unless otherwise noted on other plans.
2. Reinforcing steel, if specified by the plans, shall consist of deformed bars of grade 40 steel conforming to the requirements of ASTM Designation A615 or of wire fabric conforming to ASTM Designation A185.
3. Expansion joints shall be preformed expansion joint fillers of a non-extruding type conforming to ASTM Designation D1751.
4. Joint sealing compound for contraction and construction joints shall be one of the following types of material.

a. Hot pour polymer rubber asphaltic sealer. Immediately before applying the joint sealer, all loose debris, dust and moisture shall be removed from the joint with filtered and dry compressed air at a minimum pressure of 80 psi. Any excess sealer shall be removed from the pavement immediately after sealing. The specified sealer requires a special pot and the recommended

pour temperature is 390 degrees F. This material shall conform to ASTM D3405 and a certification shall be required from the contractor certifying the joint sealer meets this specification.

b. Cold pour polymer fortified crack fill material. Immediately before applying the joint sealer, all loose debris, dust and moisture shall be removed from the joint with filtered, dry compressed air at a minimum pressure of 80 psi. Fill each joint with sealer slightly above the pavement surface (some shrinkage will occur). Allow sealant to cure 2 to 12 hours. Do not apply sealer if ambient temperature is below 50 degrees F. This material shall generally conform to ASTM D-1190 and a certification shall be required from the contractor certifying the joint sealer meets this specification.

5. Metal supports for tiebars or reinforcing bars shall be channel shaped pressed out of 12-gauge sheet steel or heavier or as shown on the plans.
6. Dowel bars, where specified, for transverse joints shall be smooth, round bars of the size specified. Burrs, mill scale and rust shall be removed. The free end shall be painted with a suitable paint followed by a thin uniform coating or graphite grease.
7. Expansion tubes or dowel caps shall be manufactured from 32 gauge sheet metal, shall be indented to provide a limiting stop for the dowel bar and shall provide unobstructed expansion space of not less than one inch to permit movement of the dowel bar. They shall be of proper size to fit the specified bars tightly and the closed end shall be watertight.
8. Curing compound shall be an approved curing compound conforming to the requirements of ASTM Designation C309, Type 2.
9. Type I aggregate shall conform to the following requirements.

Type 1 aggregate base shall be essentially limestone or dolomite. It shall not contain more than 15 percent deleterious rock and shale. Sand may be added only for the purpose of reducing the plasticity index of the fraction passing the No. 40 sieve in the finished product. Any sand, silt, and clay, and any deleterious rock and shale shall be uniformly distributed throughout the mass. The aggregates shall conform to the following gradation requirements:

	Percent
Passing 1-inch sieve	100
Passing 1/2-inch sieve	60-90
Passing No. 4 sieve	40-60
Passing No. 40 sieve	15-35

The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six.

C. Proportion of Materials:

1. Cement content - Concrete shall contain not less than 5.75 sacks (540lbs) per cubic yard.
2. Water content - The mixing water, including free surface moisture on the coarse and fine aggregates, shall not exceed five and one half (5.5) gallons per sack of cement.

3. Air content - The concrete, when placed, shall have an air content of not less than three (3) percent nor more than six (6) percent, when tested according to ASTM C-173.
4. Slump - The concrete slump, when placed, shall be between one (1) and three (3) inches or determined by ASTM C-143.
5. Minimum compressive strength - The 28 day strength shall be a minimum of 3500 psi. as determined by ASTM C-39.
6. Mix proportion - In addition to the above requirements, the contractor shall provide a job mix with the specific portions of each part of the mix. Sieve analysis and source shall be provided for the aggregate proposed. Compression strength test for the proposed mix design shall be provided. The Engineer shall review and approve the mix design.

D. Construction Methods.

1. Four inches of Type 1 Aggregate base shall be placed under all pavements. Concrete pavement will not be placed until aggregate subgrade is approved by the Engineer.

2. Forms shall be made of metal and shall have a depth equal to or greater than the prescribed edge thickness of the pavement slab. The minimum length of each section of form used shall be ten (10) feet. Each section of form shall be uniform and free from undesirable bends or warps.

   The maximum deviation from planned grade of the top surface of any section shall not exceed one-eighth (1/8) inch, or the inside face not more than one-fourth (1/4) inch from planned alignment. The method of connection between sections shall be of such cross-section and strength and so secured as to resist the pressure of the concrete when placed, and the impact and vibration of any equipment which they support, without springing or settlement.

   The alignment and grade elevations of the forms shall be checked by the Contractor and the necessary corrections made immediately before placing the concrete. When any form has been disturbed or any subgrade thereunder has become unstable, the form shall be reset and rechecked.

3. Placing Concrete. The subgrade shall be moist at the time of placing of the concrete. If the subgrade subsequently becomes too dry, it shall be sprinkled again ahead of placing the concrete, in such a manner as not to form mud or puddles of water.

   The concrete shall be mixed in quantities required for immediate use and shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches in a continuous operation without the use of intermediate forms or bulkheads. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. While being placed, the concrete shall be vibrated with suitable tools so that the formation of voids or honeycomb pockets is prevented.

   No concrete shall be placed around manholes or other structures until they have been adjusted to the required grade and alignment.

4. Consolidating and Finishing. The pavement shall be struck off and consolidated with a mechanical finishing machine or by hand-finishing methods. When a mechanical finishing machine is used, the concrete shall be struck off at such a height that after consolidation and final finishing it shall be at the elevations as shown on the plans. A depth of excess concrete shall be carried in front of the strike-off screed for the full width of the slab, whenever the screed is being used to strike off the pavement. The finishing machine shall be provided with a screed which will consolidate the concrete by pressure. The concrete shall, through the use of this machine, be brought to a true and even surface, free from rock pockets, with the fewest possible number of passes of the machine. Hand-finishing tools shall be kept available for use in case the finishing machine breaks down.

   When hand-finishing is used, the pavement shall be struck off and consolidated by a vibrating screed or other approved equipment to the elevation shown on the plans. The vibrating screed must be approved by the Engineer, prior to placement of concrete. When the forward motion of the vibrating screed is stopped, the vibrator shall be shut off; and not be allowed to idle on the concrete. Internal mechanical vibration shall be used along side all formed surfaces. Vibration operation shall be completed prior to final hand-finishing.

5. Floating, Straightening and Edging. After the concrete has been struck off and consolidated, it shall be further smoothed by means of a wood or aluminum float at least five (5) feet wide with a handle long enough to reach the entire width of the slab being placed. The float shall be operated so as to remove any excess water and latence as well as surface irregularities. After the floating operation, the pavement surface should be within the specified tolerances.

   While the concrete is still plastic, the slab surface shall be tested for smoothness with a ten (10) foot straightedge swung from handles three (3) feet long than one-half the width of the slab. The straightedge shall be placed on the surface parallel to the centerline of the pavement and at not more than five (5) foot intervals transversely. After each test, the straightedge shall be moved forward one-half its length and the operation repeated. When irregularities are discovered, they shall be corrected by adding or removing concrete. All disturbed places shall again be floated with the wooden float and again straightedged. The pavement surface shall have no depression in which water will stand. Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab shall be carefully finished with an edger of the radius shown on the plans.

6. Final Surface Finish. A broom finish shall be used as the final finishing method. A hard bristle broom shall be used which shall be kept clean and used in such a manner as to provide a uniform textured surface.

   The final surface of the concrete pavement shall have a uniform gritty texture free from excessive roughness and true to the grades and cross section shown on the plans.

7. Joints. Longitudinal and transverse joints shall be constructed as shown on the plans.

Longitudinal joints are those joints parallel to the lane of construction. They may be either center joints or the construction joints between construction lanes.

Transverse joints shall be contraction joints or construction joints. Construction joints are put in transversely whenever construction operations require them.

Expansion joints may be either longitudinal or transverse. They are used only where specifically shown on the plans with a maximum distance between expansion joints of 500 feet for transverse type.

The edges of the pavement and those joints where such edging is shown on the plans shall be rounded with an edging as shown on the plans shall be rounded with an edger having a radius of not larger than 1/8 inch. Transverse joints, except keyed and tied construction joints, shall be continuous across the entire paved area including the curb (if provided).

a. Transverse Joints. Transverse joints shall be contraction, expansion or construction joints, or any combination. They shall make a right angle with the centerline of the pavement and have a maximum spacing of 25 feet.

   Expansion joints shall be installed in accordance with the size and locations shown on the plans. They shall extend the entire width and thickness of the pavement. The filler shall be held accurately in place during the placing and finishing of the concrete by means of a bulkhead, a metal channel cap or other approved methods.

   Transverse contraction joint shall be of the sawed type. Care must be taken to saw the joints soon after concrete placement to prevent contraction cracks. All transverse joints shall be sawed at least 1/4 of the slab depth.

   Transverse construction joints of the type shown on the plans shall be placed wherever the placing of concrete is suspended for more than 30 minutes. A butt type joint with dowels shall be used if the joint occurs at the location of a contraction joint. Keyed joints with tiebars are used if the joint occurs at any other location.

b. Longitudinal Joints. Longitudinal joints shall be placed at the pavement center line and at the pavement midpoint where the distance to the edge or another designated joint exceeds 25 feet. They shall be of the sawed or the keyed construction type.

   Sawed longitudinal center joints shall be sawed groves made with a concrete saw after the concrete has hardened. The saw cut shall be at least 1/4 of the slab depth.

   Longitudinal keyed construction joints (i.e., joints between construction lanes) shall be of the dimensions shown on the plans.

c. Tiebars. Tiebars or tiebolts shall be of deformed steel. Tiebars shall be firmly supported by subgrade chairs or so installed as not to be displaced during construction operation.

d. Joint Sealer. After the curing period, all sawed and dummy groove joints in the pavement shall be cleaned and sealed. Immediately before applying the joint sealer, all loose debris, dust and moisture shall be removed from the joint with filtered and dry compressed air at a minimum pressure of 80 psi. Joints shall be lightly underfilled (about 1/2 inch) to prevent extrusion of sealer. Any excess material has to be removed from the pavement as soon after sealing as possible.

8. Structures. All manholes catch basins, or structures of a permanent nature constructed in the area to be paved shall be adjusted to the surface of the new pavement, and the necessary expansion joint material placed around each structure for the full depth of the slab and of the thickness shown on the plans of standard drawings.

9. Curing. Immediately after the finishing operation has been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be sealed by spraying with a uniform application of curing compound, at the rate of one gallon for each 150 square feet of surface. If rain falls on the newly coated surface before the film has dried sufficiently to resist damages, or if the film is damaged in any other way, the Contractor will be required to apply additional curing material to the affected portions.

10. Cold Weather Protection. Paving operations shall be discontinued when a descending ambient temperature away from artificial heat reaches 40 degrees F and not resumed until an ascending ambient temperature away from artificial heat reaches 35 degrees F. If it is necessary for the Contractor to take precautionary measures to prevent damage by freezing, such as heating mixing water, heating aggregates or applying heat directly to the contents of the mixer; aggregates shall not be heated higher than 150 degrees F, and the temperature of the aggregates and mixing water combined shall be not higher than 100 degrees F, when the cement is added. The temperature of the mixed concrete when heating is employed shall not be less than 50 degrees F and not more than 90 degrees F at the time of placement.

11. Tolerance is Pavement Thickness. It is the intent of these specifications that pavement shall be constructed strictly in accordance with the thickness shown on the plans. The thickness of the pavement will be measured, and where any pavement is found deficient in thickness, it may be compensated for at an adjusted unit price or shall be removed and replaced.

12. Protection and Opening to Traffic. The Contractor shall protect the pavement against all damage prior to final acceptance of the work by the City. Traffic shall be excluded from the pavement by erecting and maintaining barricades and signs for at least seven days, or until the concrete pavement achieves a strength of 3,000 pounds per square inch.

13. Paving by Sip Form. Slip-forming equipment will be accepted providing it produces a paving operation in compliance with all the foregoing requirements other than forms.

8. PORTLAND CEMENT CONCRETE CURB AND GUTTER:

A. Furnish all labor, materials, and equipment to perform all operations in connection with construction of concrete curb and gutter, in accordance with the specifications and drawings, subject to the terms and conditions of the contract and where called for on the plans and specifications.

B. Materials: Concrete shall be Portland Cement Concrete conforming to ASTM C-150, Type I.

Expansion joints shall be made with preformed expansion joint filler of a non-extruding type conforming to ASTM Designation D1751, configuration of the curb and gutter as indicated on the drawings.

Joint sealing compound for contraction joints shall be MC800 asphalt or as approved by the Engineer.

Liquid curing compound shall be a white pigmented membrane forming liquid conforming to the requirements of ASTM Designation C309, Type 2.

C. Proportion of Materials:

1. Cement content - Concrete shall contain not less than 5.75 sacks (540lbs) per cubic yard.
2. Water content - The mixing water, including free surface moisture on the coarse and fine aggregates, shall not exceed five and one half (5.5) gallons per sack of cement.
3. Air content - The concrete, when placed, shall have an air content of not less than three (3) percent nor more than six (6) percent, when tested according to ASTM C-173.
4. Slump - The concrete slump, when placed, shall be between one (1) and three (3) inches or determined by ASTM C-143.
5. Minimum compressive strength - The 28 day strength shall be a minimum of 3500 psi. as determined by ASTM C-39.
6. Mix proportion - In addition to the above requirements, the contractor shall provide a job mix with the specific portions of each part of the mix. Sieve analysis and source shall be provided for the aggregate proposed. Compression strength test for the proposed mix design shall be provided. The Engineer shall review and approve the mix design.

D. Forms: Forms shall be made of metal and shall have a depth equal to or greater than the prescribed edge thickness of the pavement slab. The minimum length of each section of form used shall be ten (10) ft. Each section or form shall be straight and free from bends or warps.

The maximum deviation of the top surface of any section shall not exceed one eighth (1/8) inch, or the inside face not more than one-fourth (1/4) inch from a straight line. The method of connection between sections shall be such that the joint thus formed shall be free from movement in any direction. Forms shall be of such cross-section and strength and so secured as to resist the pressure of a concrete when planed, and the impact when planed, and the impact and vibration of any equipment which they support, without springing or settlement.

The subgrade under the forms shall be compacted and cut to grade so that the form when set will be uniformly supported for its entire length at the specified elevation. Forms shall be joined neatly and in such a manner that the joints are free from play or movement in any

direction. The supply of forms shall be sufficient to permit their remaining in place for at least 12 hours after the concrete has been placed. All forms shall be cleaned and oiled each time they are used.

The alignment and grade elevations of the forms shall be checked by the contractor and the necessary corrections made by the contractor immediately before placing the concrete. When any form has been disturbed or any subgrade thereunder has become unstable, the form shall be reset and rechecked.

E. Placing Concrete: The subgrade shall be moist, but not muddy, at the time of placing of the concrete. If required by the Engineer, the prepared subgrade shall be saturated with water the previous night, or not less than 6 nor more than 20 hours prior to placing the concrete. If the subgrade subsequently becomes too dry, it shall be sprinkled again ahead of placing the concrete, in such a manner as not to form mud or puddles of water.

The concrete shall be mixed in quantities required for immediate use and shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation without the use of intermediate forms of bulkheads. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. While being placed, the concrete shall be spaded or vibrated and compacted with suitable tools so that the formation of voids or honeycomb pockets is prevented.

The concrete shall be especially well spaded or vibrated and tamped against the forms and along all joints. Care shall be taken in the distribution of the concrete to deposit a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab.

No concrete shall be placed around manholes or other structures until they have been brought to the required grade and alignment.

F. Finishing: The curb shall be tooled to the required radii as soon as possible after the concrete takes its initial set. The gutter shall be shaped with a wood float at least four feet long. After the face forms and templates are removed, the joints shall be tooled and the surface finished with a wood float to remove all imperfections without additional mortar or dryer. In all cases the resulting surface shall be smooth and of uniform color, free from sags, twists or warps and true to the specified lines and grades shown on the plans.

G. Joints: Expansion joints shall be formed with bituminous preformed expansion joints 3/4" thick and precut to exact cross section of curb shall be placed at all driveway radii and intersection radii and at intervals of not more than 200 feet, and at the location shown on the plans, so that they are not moved by depositing and compacting the concrete at these joints. Preformed expansion joint filler shall be of non-extruding type and shall conform to ASTM Designation D1751.

Contraction Joints: Contraction joints shall be sawed or formed with templates at intervals between 25 and 30 ft. and at the location shown on the plans and shall be sawed to a depth of one and one-half (1-1/2) inches. Asphaltic material used in filling these joints shall be MC-800 or approved equal. Contractor joints in proposed medians shall match those joints in pavement. A template shall be 1/4 inch thick, cut to the configuration of the curb section shown on the plans. Templates shall be secured so that they are not moved by depositing and compacting the concrete.

H. Curing: Immediately after the finishing operation has been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be sealed by spraying with a uniform application of white pigmented membrane curing material, at the rate of one gallon for each 150 sq. ft. of surface. If rain falls on the newly coated surface before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the contractor will be required to apply additional curing material to the affected portions.

I. Cold Weather Protection: Cold weather protection shall be provided in these specifications entitled "Portland Cement Concrete Pavement".

J. Curb and gutter laid by slip-form or extruding equipment will be accepted providing it complies with all of the above requirements other than forms.

H. After curing the curb shall be immediately backfilled to within 4" of the top of curb to eliminate any possibility of washing beneath the curb. The remaining 4" shall be top soil.

9. PORTLAND CEMENT CONCRETE SIDEWALK AND DRIVEWAYS:

A. Sidewalks: This section covers the furnishing of all labor, tools, equipment and material and the performance of all work necessary to construct sidewalks complete including grading and subgrade preparation at the location shown on the plans. **Sidewalks shall have a minimum thickness of 4"** except at driveways where the thickness shall be 6", **with 4" of Type 1, Aggregate Base.**

1. Materials: Same as Portland Cement Concrete Paving
2. Proportion of Materials: Same as Portland Cement Concrete Paving
3. Forms: Forms shall be metal or wood and shall have a depth approximately equal to the edge thickness of the sidewalk. Forms shall be in good condition, straight and free from bends or warps. They shall be held securely in place by stakes or braces with the top edge true to line and grade as shown on the drawings.
4. Placing and Finishing: The subgrade shall be moistened just before the concrete is placed. Concrete shall be placed in successive batches for the entire width of the slab, struck off from 1/2 to 3/4 inch higher than the finished slab, tamped until all voids are removed and free mortar appears on the surface, thoroughly spaded along the edges, struck off to the true grade and finished to a true and even surface with a wood float. After the water has disappeared, the surface shall be given a final finish by brushing with a white-wash brush. The brush shall be drawn across the sidewalk at right angles to the edges of the walk, with adjacent strokes lightly overlapping, producing a uniform, slightly roughened surface with parallel brush marks.

The surface shall be divided by grooves constructed at right angles to the centerline of the sidewalk. These grooves shall extend to 1/4 the depth of the sidewalk, shall not be less than 1/8 inch nor more than 1/4 inch in width, and shall be edged with an edging tool having a 1/4 inch radius. No slab shall be longer than 6 feet nor less than 4 feet on any one side, unless otherwise ordered by the Engineer. Edges of the slab shall be edged as described above.

Expansion joints of the thickness specified on the plans shall consist of preformed joint filler and the top of the joint filler shall be placed 1/4 inch below the surface of the sidewalk. Expansion joints shall be placed between the sidewalk and all structures such as light standards, traffic light standards, traffic poles and columns, which extend through the sidewalk.

Expansion joints shall be placed at intervals not to exceed 100 feet. Expansion joints shall be placed where the sidewalk abuts existing sidewalks, between driveway pavement and sidewalk.

5. Curing: Immediately after finishing has been completed, the entire surface of the newly placed concrete shall be sealed by spraying with a uniform application of liquid curing compound at the rate of one gallon for each 150 sq. ft. of surface.
6. Backfill: Immediately after the concrete has been cured, the spaces along the exposed edges of the sidewalk shall be backfilled to the required elevation with material approved by the Engineer, compacted until firm and the surface neatly graded.
7. Surplus or waste material resulting from sidewalk construction operations shall be disposed of by the Contractor.

B. Driveways: This work shall consist of a Portland Cement concrete driveway constructed on a prepared subgrade in accordance with the specifications and plans and as required by the Engineer. **Minimum thickness shall be 6", with 4" Type 1, Aggregate Base.**

1. Materials and construction methods shall be the same as that required for Portland Cement concrete sidewalk as far as they apply to driveways.
2. Driveways within the street right-of-way shall be constructed of Portland Cement concrete, six inches in thickness. Driveways on private property shall be replaced to the same thickness as that removed. Placement, finishing and curing shall be carried out in accordance with the provisions for concrete payment.

10. PAVED DITCH:

A. Furnish all labor, materials, and equipment to perform all operations in connection with construction of a paved ditch, in accordance with the specifications and drawings, subject to the terms and conditions of the contract and where called for on the plans and specifications. Minimum thickness shall be 6".

B. Materials: Same as Portland Cement Concrete Paving.

C. Forms: Same as Portland Cement Concrete Paving.

The subgrade under the forms shall be compacted and cut to grade so that the form when set will be uniformly supported for its entire length at the specified elevation. Forms shall be joined neatly and in such a manner that the joints are free from play or movement in any direction. The supply of forms shall be sufficient to permit their remaining in place for at least 12 hours after the concrete has been placed. All forms shall be cleaned and oiled each time they are used. The alignment and grade elevations of the forms shall be checked by the contractor and the necessary corrections made by the contractor immediately before placing the concrete. When any form has been disturbed or any subgrade thereunder has become unstable, the form shall be reset and rechecked.

D. Placing Concrete: The subgrade shall be moist, but not muddy, at the time of placing of the concrete. If the subgrade subsequently becomes too dry, it shall be sprinkled again ahead of placing the concrete, in such a manner as not to form mud or puddles of water.

The concrete shall be mixed in quantities required for immediate use and shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation without the use of intermediate forms of bulkheads. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. While being placed, the concrete shall be spaded or vibrated and compacted with suitable tools so that the formation of voids or honeycomb pockets is prevented. The concrete shall be especially well spaded or vibrated and tamped against the forms and along all joints.

E. Finishing: The surface shall be finished smooth and even. All edges shall be rounded with an edging tool having a 1/4-inch radius.

F. Curing: All concrete shall be protected against rapid drying and shall be kept moist for at least the first six days after placing. The surfaces of all concrete from which forms have been removed prior to six days after placing shall be thoroughly saturated at least twice daily with burlap or tarpaulin and kept wet until concrete is six days old. Membrane type curing compounds may be used.

G. Joints: Expansion joints shall be formed with bituminous preformed expansion joints 3/4" thick and precut to exact cross section of the paved ditch and shall be placed at intervals of not more than 200 feet, and at the location shown on the plans, so that they are not moved by depositing and compacting the concrete at these joints. Preformed expansion joint filler shall be of non-extruding type and shall conform to ASTM Designation D1751.

H. Protection from cold: When placing concrete at or below a temperature of 40 degrees F. or whenever, in the opinion of the Engineer, atmospheric temperatures will probably fall below this limit within 24 hours, after placing concrete either the mixing water or aggregate or both shall be heated and freshly placed concrete protected by adequate housing or covering and heating. Concrete placed in the form shall have a temperature of not less than 70 degrees F, 50 degrees F, for not less than 4 days after placing. The use of salts, chemicals or other foreign materials in the mix to lower the freezing point of the concrete is prohibited.

I. Paved ditch laid by slip-form or extruding equipment will be accepted providing it complies with all of the above requirements other than forms.

11. ROCK DITCH LINING:

A. Furnish all labor, materials, and equipment to perform all operations in connection with construction of a rock ditch lining, in accordance with the specifications and drawings, subject to the terms and conditions of the contract and where called for on the plans and specifications. All work and materials shall conform to Section 609, of MoDOT Standard Specifications.

12 PRECAST DRAINAGE STRUCTURES:

A. Furnish all labor, materials, and equipment to perform all operations in connection with construction of curb inlets, drop inlets, and manholes and junction boxes in accordance with the specifications and drawings, subject to the terms and conditions of the contract and where called for on the plans and specifications. Structures shall comply with Section 614, 731, and 1033, of MoDOT Standard Specifications.

13. WEATHER LIMITATIONS:

A. Bituminous mixtures shall not be placed:

1. When either the air temperature or the temperature of the surface on which the mixture is to be placed is below 40° F, or;
2. On any wet or frozen surface, or;
3. When weather conditions prevent the proper handling or finishing of the mixture.

14. ACCEPTANCE OF IMPROVEMENTS:

A. All utilities and improvements which are to be installed in street right-of-ways shall be completed prior to the installation of the curb and gutter and pavement construction.

15. INSPECTIONS:

A. The required inspections as hereby listed:

1. When construction is started;
2. After subgrade has been prepared;
3. When curb construction is started;
4. After curbs are finished;
5. After curb backfill is completed;
6. Before the black base is placed;
7. During black base placement;
8. When asphalt hot mix wearing surface is being placed;
9. After completion of all streets and utility construction, but not later than one year after the recording date of the final plat, all right-of-way pins must be set defining the right-of-way;
10. Final inspection for approval.

B. The following documentation must be furnished:

1. Copy of all concrete tickets,
2. Copy of all bituminous plan mix tickets,
3. Copy of all hot mix asphalt tickets.
4. Core test will be taken at Developer's expense (check for thickness).
5. Slump tests will be taken during concrete pours.
6. Air tests will be taken during concrete pours.
7. Concrete that fails to meet design specifications for slump and entrained air will be rejected at time of test.

16. ROADWAY TRENCH BACKFILLING

A. Any cuts or excavations within 2 feet of the driving surface shall be backfilled with wet crushed limestone base a minimum of 12" deep in compacted lifts of no more the 6". Each lift shall be tamped thoroughly with a mechanical tamper before succeeding layers are placed. These cuts or excavations must be repaired within 15 days; no exceptions.

B. The contractor shall have the option of backfilling to the surface within the right-of-way with clean crushed rock or paying the cost of compaction tests as deemed necessary by the City. Backfill and bedding material shall be crushed stone or crushed gravel conforming to the requirements of ASTM Standard C33, and having a gradation as follows:

	Percent by Weight
Passing 5/8" sieve	100
Passing 1/8" sieve	75-100
Passing 3/8" sieve	30-75
Passing #4 sieve	5-25
Passing #8 sieve	0-6

C. If the rock backfill is used, a ditch check will be required at a minimum of every 300 feet. City may require flowable concrete backfill.

D. Cuts or excavations within the driving surface, if determined to be necessary by the City, shall be repaired as per Standard Details attachment. Concrete and asphalt must meet the Missouri Standard Specifications for Highway Construction. These cuts or excavations must be temporarily repaired within 24 hour period; no exceptions.

17. GRADING AND SEEDING:

A. Scope: Seeding shall occur to repair/replace all disturbed lawn, parkway and other grass area within and adjoining the project. Where no sidewalks exist, the parkway shall be the area between the curb and the right-of-way line. Where there are existing sidewalks, the parkway shall be the area between the curb and the sidewalk. Where an open ditch exists the partway shall extend from the backslope to the right-of-way line.

B. Materials:

1. Topsoil: Topsoil shall consist of a fertile, friable soil of loamy character, free of sub-soil, stumps, refuse and other foreign material. It shall contain a normal amount of natural humus and be reasonably free of roots, hard dirt, heavy or stiff clay, coarse sand, noxious weeds, noxious weed seeds, sticks, brush, and other litter. The topsoil shall be obtained from well-drained, arable land, and be of an even texture so that all the soil will pass a ½" screen. The topsoil shall not be infested with nematodes or with any other noxious animal life or toxic substances. Sandy loam of low fertility, even though mixed with leaf mold, manure, or other fertilizers, will not be accepted.
2. Seed Mixture: The seed shall be of the following mixture as follows. The following percentage of purity and germination will be the minimum requirements in the acceptance of seed.

	MIXTURE	PURITY	GERMINATION
Kentucky Blue Grass	50%	80%	65%
Creeping Red Fescue	40%	95%	90%
White Clover	5%	95%	85%
Annual Rye Grass	5%	98%	90%

The seed shall be free from Johnson Grass, Canadian Thistle, or field bind weed seed, and shall not contain more than two (2%) percent of other weed seeds. A certification of this mixture shall be furnished to the Engineer prior to seeding.

3. Fertilizer: Fertilizer shall be a mixture containing twelve (12) pounds each of soluble nitrogen, phosphoric acid and potash per one hundred (100) pounds.
4. Mulch: Type 1 mulch conforming to Section 802 of the Missouri Standard Specification for Highway Construction, latest edition.

C. Grading and Seeding: Unless otherwise specified, all disturbed lawn or parkway areas shall be graded as shown on the plan with at least four (4) inches of topsoil in place.

Before final raking, areas to be seeded shall be fertilized with the specified mixture by spreading evenly at the rate of twelve (12) pounds per thousand (1,000) sq. ft. of area using a mechanical spreader of the rotary type. The area shall then be raked to a smooth even surface, the soil loosened to a depth of at least one (1) inch and seeded. The seed shall be evenly distributed over the area at the rate of five (5) pounds per one thousand (1,000) sq. ft. using a mechanical spreader over all disturbed areas including slopes, ditches, and parkways.

All seeded areas shall be covered by a light covering of straw, approximately one-quarter (1/4) inch in depth. The seeded area shall be maintained as necessary until the project is completed.

Seeding shall not be placed from June 1 to September 1 nor from November 1 to March 15.

18. STORM DRAIN PIPING:

A. Excavation: If the pipe is to be laid below the ground line, the trench shall be excavated to the required depth. The bottom of the trench shall be shaped to conform to the bottom of the pipe for at least 10 percent of its overall height and shall afford a uniformly firm bed throughout its entire length. In lieu of shaping the trench the pipe may be placed on a 2" thick bed of sand and backfilled with sand to 10% of the pipe diameter. If rock is encountered, the trench shall be excavated 6" below the bottom of the pipe, and backfilled with suitable material thoroughly compacted and shaped. Soft or yielding material shall be removed and replaced with suitable material tamped thoroughly into place. If the pipe is not laid in a trench, a uniformly firm bed shall be provided.

B. Laying Flexible Pipe: The pipe shall be carefully laid true to lines and grades shown on the plans, with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. If pipe sections are joined on the work, the ends shall be butted as closely as the corrugations will permit and shall be joined with a firmly bolted coupling band of the same material as the pipe. Multiple culverts, unless shown otherwise on the plans, shall be laid with ½ span of the pipe, or a minimum of 1 ft. which is the greater, between the culverts. Any pipe which is not in true alignment or which shows any undue settlement after laying shall be taken up and relaid at the contractor's expense. If shown on the plans, or directed by the Engineer, camber shall be built into the pipe structure to compensate for settlement from fill loads.

Proper care shall be taken during handling and installation to avoid damage to metallic coating or cladding. Pipe on which such coatings has been damaged may, unless repaired to the satisfaction of the Engineer, be rejected at the site of the work regardless of previous approvals.

Pipe having any localized bends in excess of 5% of the specified pipe diameter, or any dent in excess of 1/2", will be rejected. Pipe rejected because of these defects may be used if satisfactorily repaired. Repair may be made by jacking or by any other method meeting the approval of the Engineer.

C. Laying Rigid Pipe: Rigid pipe shall be carefully laid true to lines and grades shown on the plans, with hub, bell, or groove ends upstream, and with the spigot or tongue end entered the full length into the adjacent section of pipe. If the pipe is to be laid below the ground line, a trench shall be excavated to the required depth and of a width sufficient to permit thorough tamping of the backfill under the haunches and around the pipe. Any pipe which is not in true alignment or which shows any undue settlement after laying, but before the fill is placed, shall be taken up and relaid at the contractor's expense. If shown on the plans, or directed by the Engineer, sufficient camber shall be built into the pipe structure to allow for settlement from fill loads. All joints, except for field or private entrance culverts, shall be sealed with an approved plastic compound or cement mortar. Where permissible lift holes have been used, the holes shall be carefully filled with expansive mortar to provide a watertight section. The mortar shall be finished flush on the inside of the pipe and shall be properly cured on the outside. Lifting devices shall have sufficient bearing on the inside of the pipe to avoid damage resulting from a concentration of stresses around the lift holes.

D. Backfilling: Backfilling shall be done as soon as practicable. Suitable backfill and embankment material, free from large lumps, clods, or rocks, shall be placed alongside the pipe in loose layers not exceeding 6" thick to provide a berm of compacted or undisturbed earth, on each side of the pipe, at least as wide as the external diameter of the pipe. Each 6" layer shall be thoroughly compacted to the same density required for the adjacent embankment. Backfill material shall be moistened, if necessary, to facilitate compaction. Special care shall be taken to compact the embankment thoroughly under the haunches of the pipe. Filling and compacting shall be continued until the embankment is level with the top of the pipe if the top of the pipe is above the original surface, otherwise it shall be continued until the embankment is level with the original surface. Before heavy construction equipment is operated over the pipe, the contractor shall provide an adequate depth and width of compacted backfill to protect it from damage or displacement. Any damage or displacement shall be repaired or corrected at the contractor's expense.

Pipe laid on a sand bed shall be backfilled with sand for at least 10% of its overall height. The sand shall be thoroughly compacted by the use of tampers or by flooding. The remainder of the backfill shall be in accordance with other provisions of this Specification.

19. STORM DRAIN PIPE MATERIALS:

A. Pipe: Pipe shall be of the type, size, and class shown on the plans.

B. Reinforced Concrete Culvert Pipe: Reinforced concrete pipe shall conform to the requirements of the Specifications for Reinforced Concrete Culvert Pipe, ASTM Designation C76. Unless otherwise shown on the plans, installation shall be made with circular pipe conforming to the requirements for Class III, Wall B of this ASTM Specification. When reinforced concrete elliptical pipe is to be used, installation shall be made with pipe conforming to the requirements of ASTM Designation C507, Class HE-111.

C. Corrugated Steel, Zinc Coated Pipe: Corrugated steel zinc coated pipe shall conform to the requirements of the Specifications for Corrugated Steel Zinc Coated Pipe, ASTM Designation A760. The type of pipe required shall be either circular or other configuration as indicated on the plans or specifications. If pipe with helical corrugations is used, the ends shall be rerolled to form circumferential corrugations extending at least two corrugations from the pipe ends. Bands with projections (dimples) will not be accepted. Pipe wall thickness shall be a minimum 0.064" or as provided in Table I of Section 725 of the Mo. Std. Spec. for Highway Construction, latest edition.

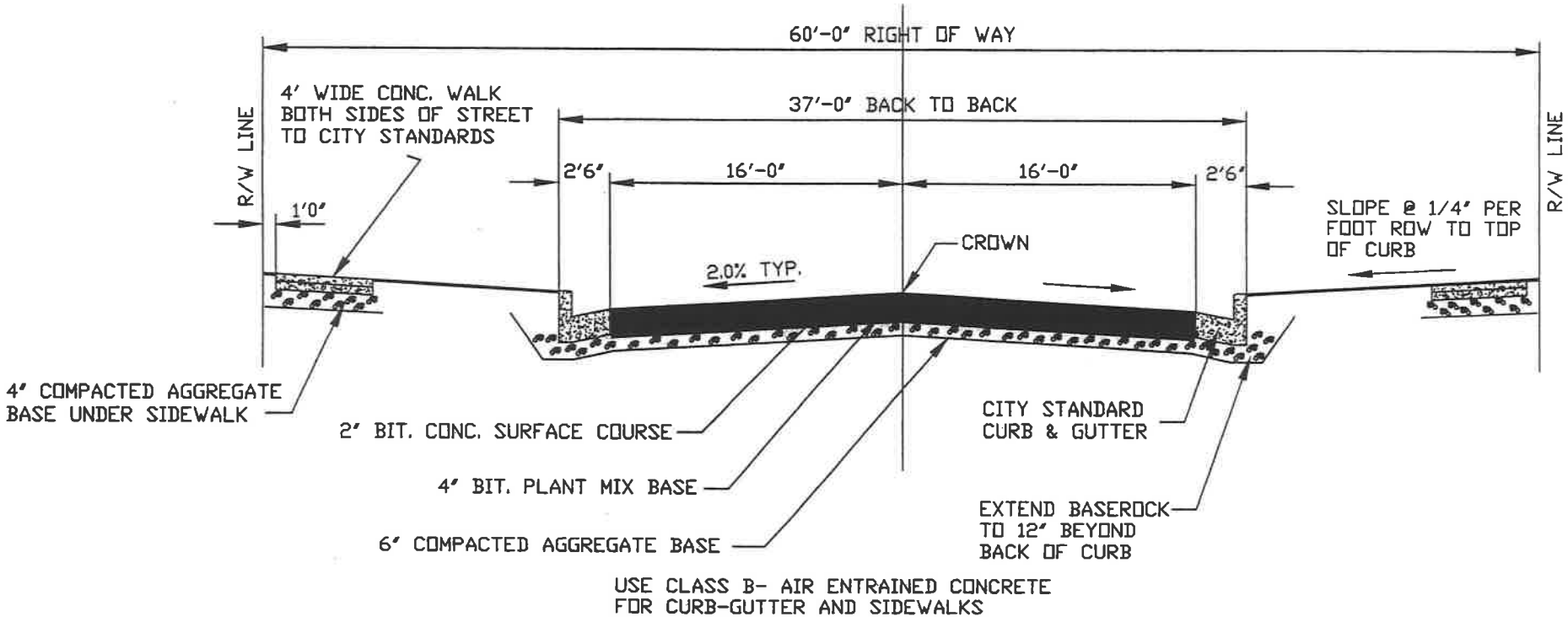
D. Concrete Pipe Joints: Joints for concrete pipe shall be any of the following:

1. Flexible Neoprene Gaskets of the proper size conforming to the requirements of ASTM Designation C443.
2. Bituminous Mastic Joint Compound. This compound shall be a homogeneous blend of bituminous material, inert filler, and suitable solvents or plasticizing compounds thoroughly mixed at the factory to a uniform consistency.
3. Mortar consisting of one part Portland Cement and two parts of approved sand mixed with sufficient water to work a plastic mixture.
4. Inspection: After the roadway has been completed and before final acceptance of the project, all pipe culverts will be inspected. Any separation at joints sealed with either cement mortar or plastic joint compound shall be resealed with like material.

20. DRAWINGS:

A. The attached drawings are made a part of this specification.

\\Server\projects-m\03-202\Specs\section14.wpd



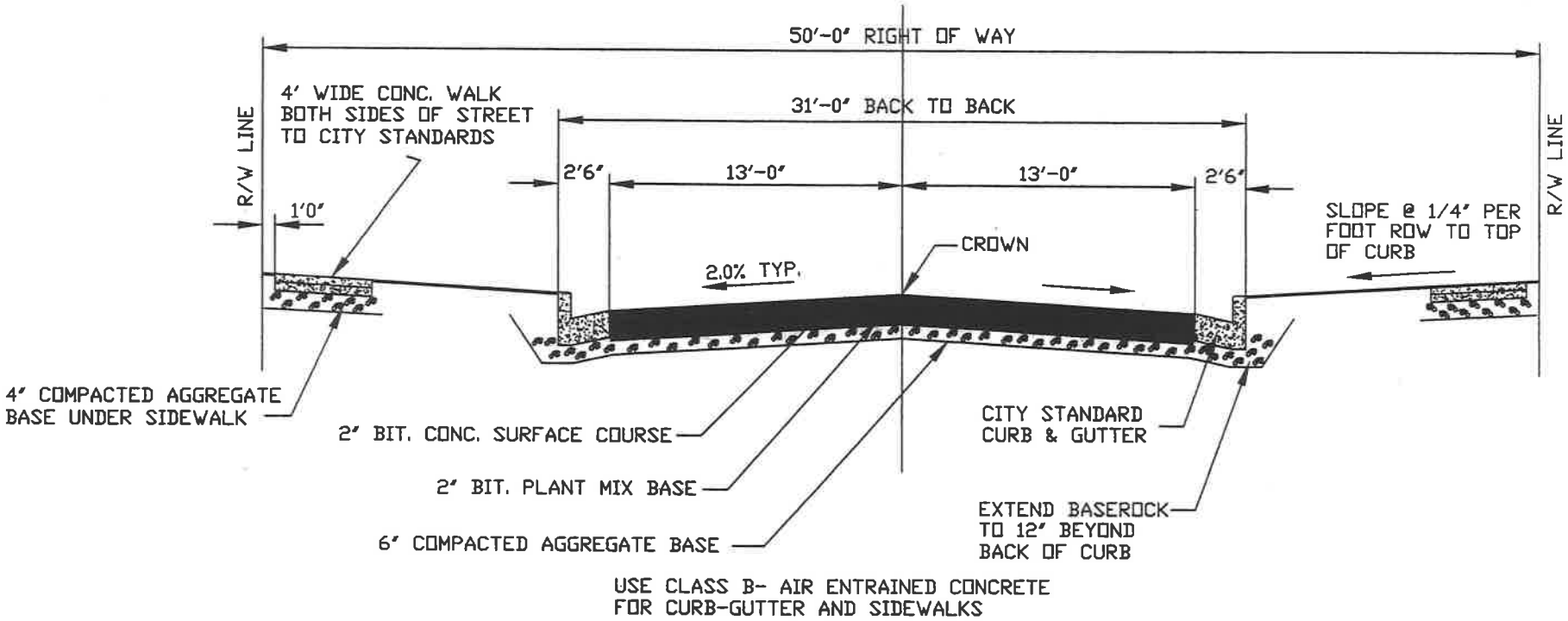
TYPICAL ROADWAY SECTION

NOT TO SCALE

(NON-RESIDENTIAL COLLECTOR)

STREET2 6-23-03

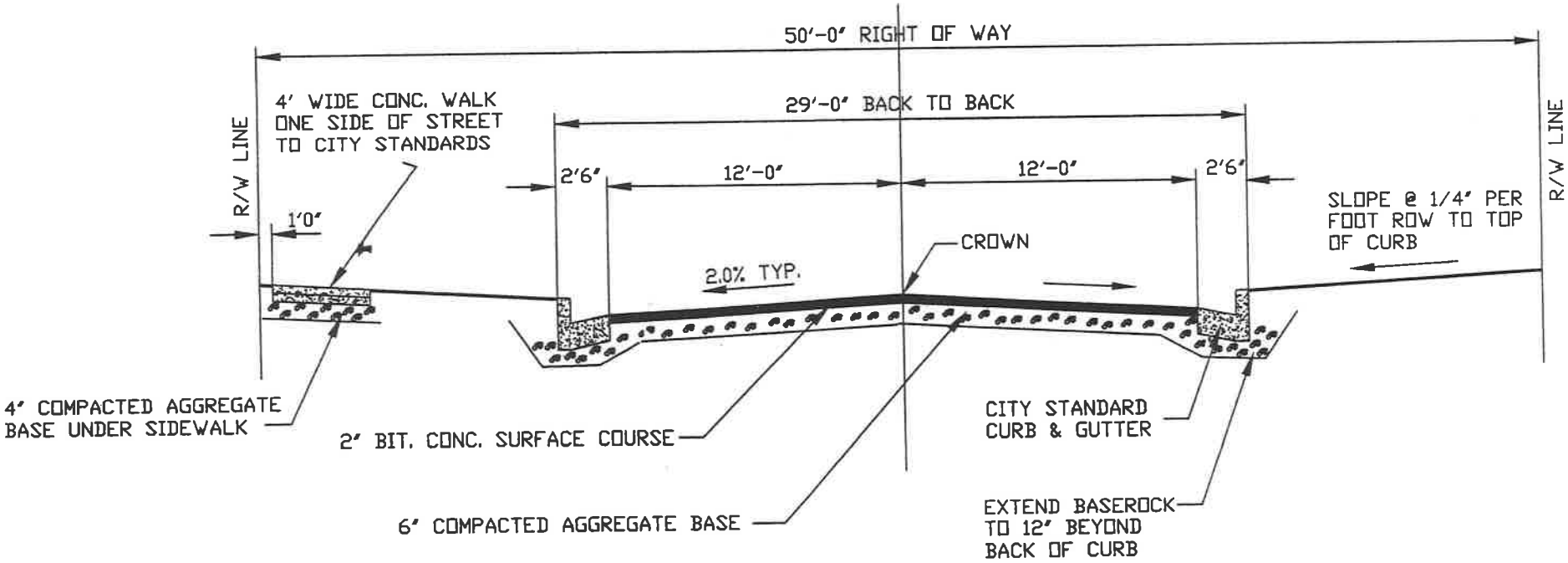
STREET DETAILS



TYPICAL ROADWAY SECTION

NOT TO SCALE

(RESIDENTIAL COLLECTOR)



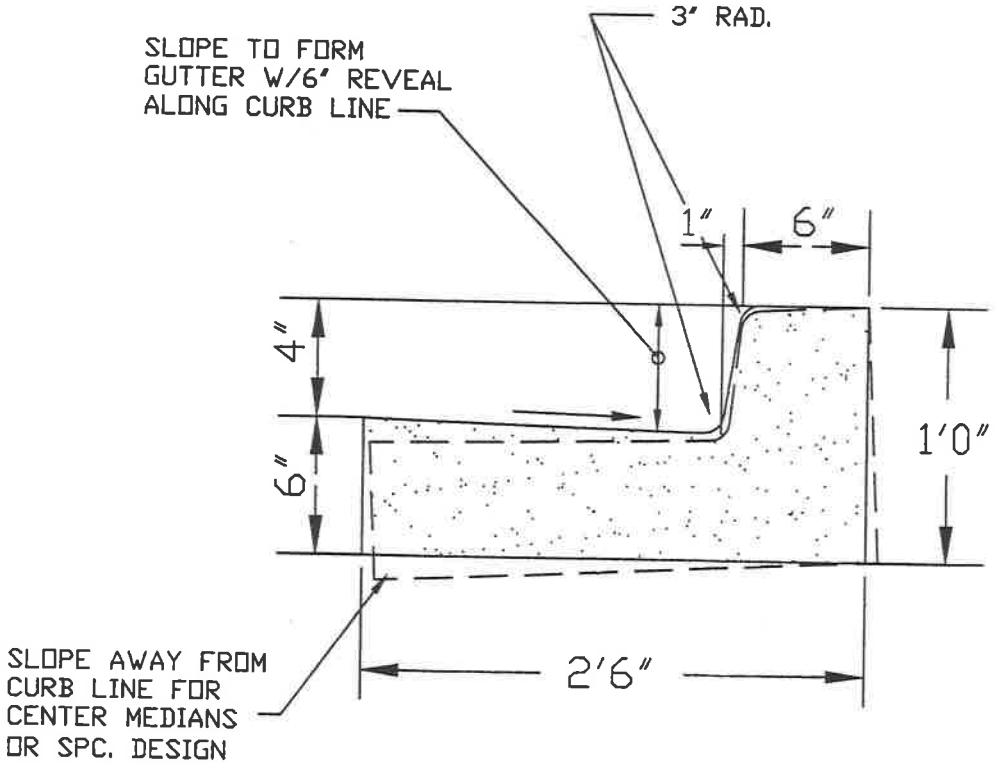
USE CLASS B- AIR ENTRAINED CONCRETE
FOR CURB-GUTTER AND SIDEWALKS

TYPICAL ROADWAY SECTION

NOT TO SCALE

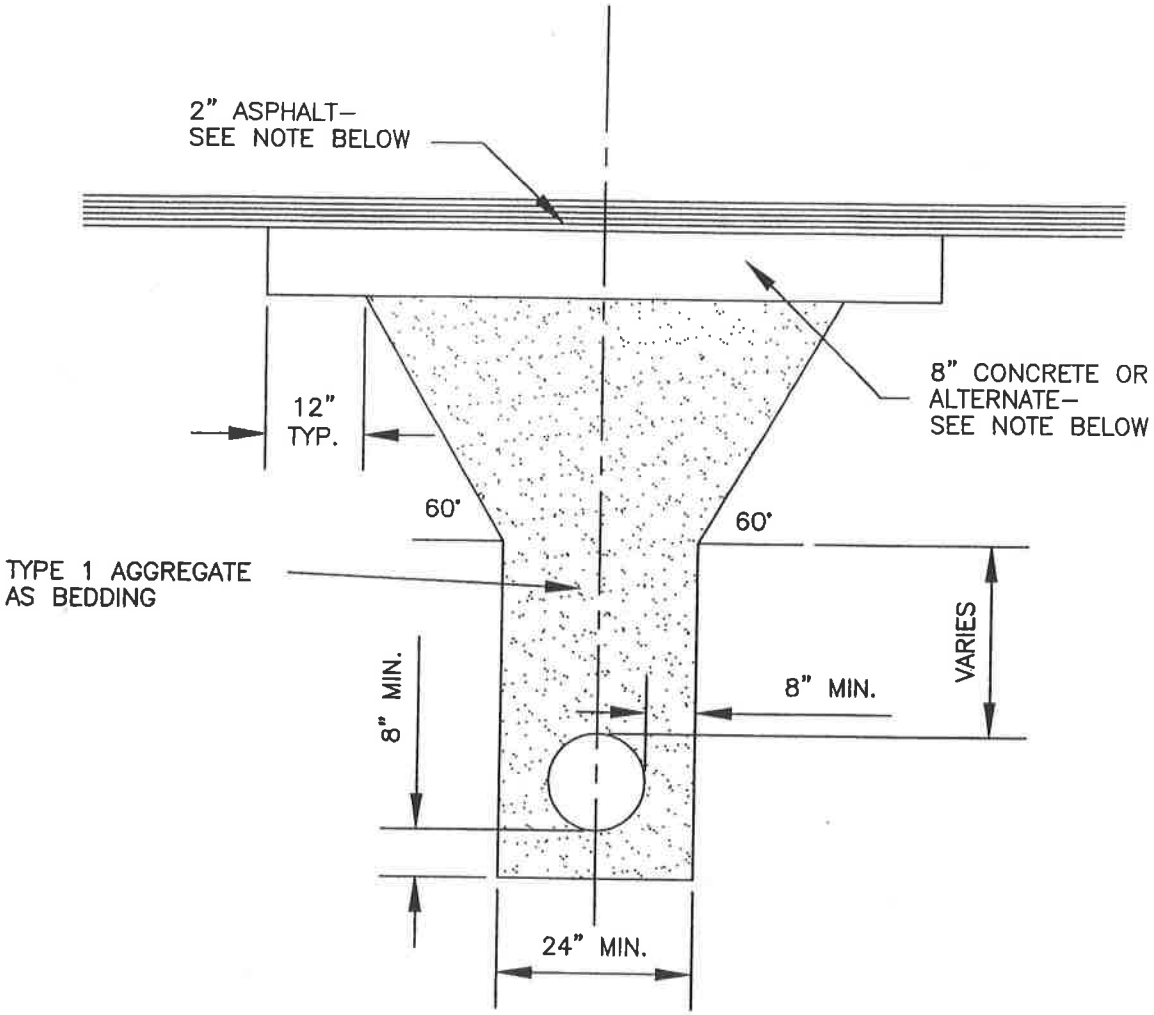
(LOCAL STREET)

STREET DETAIL



CONCRETE CURB & GUTTER

NOT TO SCALE



STREET CUT FOR UTILITES

NOT TO SCALE

NOTES:

1. ALL MATERIAL AND PLACEMENT OF MATERIAL MUST MEET THE SPECIFICATIONS SET FORTH IN THE LATEST EDITION OF THE MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION.

2. ASPHALT TOP– 2" MINIMUM HOT MIX LAID LEVEL WITH EXISTING ROAD SURFACE.

3. CONCRETE BASE– HIGH EARLY PAVING, 4,000 PSI A/E, THE ALTERNATE IS 10" OF PLANT MIX ASPHALT BASE COURSE.

4. BEDDING SHALL BE TYPE 1 AGGREGATE COMPACTED IN 8" LIFTS.

5. EXISTING PAVING SHALL BE SAWCUT AND REMOVED FROM THE SITE.

FILE: STREETS 6-23-03

Resolution # 03-01

City of Forsyth, Missouri
A Resolution Modifying Design Manual

Whereas, The City of Forsyth wants to promote the economic development of the Forsyth area, and

Whereas, The City of Forsyth seeks to protect the environment of the area,

Now Therefore Be it resolved by the Board of Aldermen of the City of Forsyth as follows:

That Article IV read as follows:

Sec. 1. Curbs and gutters shall be required in all commercial subdivisions.

Sec. 2. Curbs and gutters are not required in residential subdivisions if the surface drainage can be adequately controlled with a ditched system constructed in accordance with the construction specifications of the City of Forsyth.

Sec. 3. Curbs and gutters are not required in residential subdivisions that have an average lot area of three (3) acres or more.

Sec. 4. Curb and gutters are not required on divided land or third lane parkways when the design is part of an approved plat.

Sec. 5. Curb and gutter shall be 30" wide, 6" minimum thickness of Portland Cement Concrete, 6" top of curb to gutter dimension.

That this section be added to Section VIII

33. Low Pressure Wastewater Systems

Sec. 1. Nothing in this Chapter shall prevent a new residential subdivision form utilizing a low-pressure system that meets the approval of the Department of Natural Resources of State of Missouri.

Sec 2. That all plans for low-pressure systems be sealed by a registered engineer in the State of Missouri and must meet the approval of the City Engineer.

Sec. 3. That all initial sales of lots fully disclose that the grinder pump and parts of the system on private property are to be maintain by the owner and are not the responsibility of any government entity including the City of Forsyth.

Sec. 4. An independent engineering firm hired by the City and paid for by the party requesting the review will arbitrate any part of the design manual that is in conflict with a low-pressure design for a preliminary plat. The judgment of the independent engineering firm will be final.

Passed and truly agreed to on this date.

March 2004

Mayor

City Clerk

SECTION XV

STREET LIGHTING

SPECIFICATIONS

1. General
2. Standards for Street Lights and Appurtenances
3. Construction Methods
4. Acceptance

STREET LIGHTING
SPECIFICATION

1. GENERAL

a. This specification covers street lighting in the following areas.

(1) Addition of street lights in exiting neighborhoods.

(2) Required street lighting in new developments.

2. STANDARDS FOR STREET LIGHTS AND APPURTENANCES

a. Existing neighborhoods where new lights are to be furnished by Empire Electric shall conform to Empire Electric specifications. These lights shall be high-pressure sodium vapor type, 150W.

b. Existing neighborhoods where poles and fixtures are to be installed by the City or by contract shall conform to the requirements herein.

c. New development or areas for more than one new street light shall conform to the following:

(1) The developer shall submit a street lighting system plan designed by a Registered Professional Engineer or Empire District Electric. The plan shall clearly show all street light locations, routing and design of secondary power service to all light fixtures, type and style of pole, type and style of fixtures, rating and illumination data for fixtures, and details of user connection to Empire Electric.

(2) Poles shall be wooden conforming to Empire Electric specifications for height of pole, steel, cast iron, or aluminum. All poles shall be designed to withstand 80-mph wind gusts without distortion with all appurtenances attached. All poles mounted on a base assembly shall be of the bread-a-way type.

(3) Unless specifically authorized all power circuits shall be underground, 240 volt, single phase run in 1-1/2 inch schedule 40 PVC conduit.

(4) Fixtures shall be high-pressure sodium vapor type of sufficient wattage to provide for 9,000 to 10,000 lumen coverage for residential areas, or 25,000 to 30,000 for commercial areas.

(5) All electrical work shall conform to the National Electric Code of the current issue used by the City Building Department.

d. All street lights shall be on City streets or parking areas.

3. CONSTRUCTION METHODS

a. All construction shall conform to the National Electric Code and all City codes.

b. Work shall be done using experienced, competent workers.

c. All equipment used shall be in proper working condition and be designed for the type of work being done.

d. Adequate supervision of the work shall be on site.

e. The contractor or utility company performing the work shall conform to all Federal, State, and local regulations pertaining to safety, and shall be solely responsible for that compliance and any resulting events.

f. Before final acceptance the area shall be graded, rocks and construction debris removed, fertilized, mulched and seeded with a lawn mix free of weeds.

4. ACCEPTANCE

a. Upon completion of the lighting , a final inspection shall be requested.

b. The City will inspect the completed facilities and make recommendations to the Board of Aldermen to accept the approved work.

c. The contractor shall guarantee the materials and workmanship for a period of one (1) year from the date of final acceptance.

Resolution # 03-01

City of Forsyth, Missouri
A Resolution Modifying Design Manual

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Whereas, The City of Forsyth seeks to protect the environment of the area,

Now Therefore Be it resolved by the Board of Aldermen of the City of Forsyth as follows:

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Sec. 2. Curbs and gutters are not required in residential subdivisions if the surface drainage can be adequately controlled with a ditched system constructed in accordance with the construction specifications of the City of Forsyth.

Sec. 3. Curbs and gutters are not required in residential subdivisions that have an average lot area of three (3) acres or more.

Sec. 4. Curb and gutters are not required on divided land or third lane parkways when the design is part of an approved plat.

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Passed and truly agreed to on this date.

March 2004

Mayor

City Clerk

Sec. 4 The engineer shall prepare the plans in accordance with the minimum conditions which are identified in this manual.

Sec. 5 The customer shall be responsible for all cost of engineering, construction and any associated cost resulting from the street, parking and drainage improvements.

Sec. 6 The City will provide written approval for the improvements. The City reserves the right to not approve any improvements.

ARTICLE IV
CURB AND GUTTER

Sec. 1 Curbs and gutters shall be required in all subdivisions unless the Board shall find all the following conditions to exist:

A. The average lot area in a residential subdivision is three (3) acres or in excess of three (3) acres.
B. Surface drainage can be adequately controlled with a ditched system constructed in accordance with the construction specifications for the City of Forsyth.
C. Curb and gutter may be required in order to extend the existing curb and gutter or where curb and gutter is required to control erosion.

Sec. 2 Curb and gutter shall be 30" wide, 6" minimum thickness of Portland Cement Concrete, 6" top of curb to gutter dimension.

ARTICLE V
SUB-BASE

Sec. 1 Non-residential collector streets or streets intended for use within commercial and industrial subdivisions shall have a minimum of 4" of bituminous plant mix base over 6" of compacted Type 1, aggregate base rock (95% and over compaction).

Sec. 2 Collector streets for primarily residential traffic shall have a minimum of 2" of bituminous plant mix base over 6" of compacted Type 1, aggregate base rock (95% per and over compaction).

Sec. 3 Local streets for primarily residential traffic shall be a minimum of 6" of compacted Type 1, aggregate base rock (95% and over compaction).

Sec. 4 Arterial streets to be determined case by case.

Sec. 5 Sub-base preparation and placement must meet the Missouri Standard Specifications for Highway Construction, Division 300, Bases and Aggregate Surfaces.