

City of Pacific

**CONSTRUCTION
STANDARDS
&
SPECIFICATIONS - 2009**



CITY OF PACIFIC

300 Hoven Drive • Pacific, Missouri 63069-1158
(636) 271-0500
Telefax: (636) 257-7017

Paragraph	Title	Page
1.	INTRODUCTION	1.1
1.1.	Purpose	1.1
1.2.	Authority	1.1
1.3.	Discussion	1.1
1.3.	Organization	1.2
2.	DEFINITIONS	2.1
3.	STREETS AND PARKING	3.1
3.1.	Street Design Criteria	3.1
3.1.1.	Arterial Streets	3.1
3.1.2.	Collector Streets	3.2
3.1.3.	Minor Streets	3.3
3.1.4.	Cul-de-Sacs	3.4
3.1.5.	Alleys	3.5
3.2.	Street Improvements	3.5
3.2.1.	Grading and Surfacing Required	3.5
3.2.2.	Missouri Department of Transportation Approval	3.6
3.2.3.	Subdivisions Adjacent to Existing City Streets	3.6
3.2.4.	Future Access	3.6
3.2.5.	Street Design	3.6
3.2.6.	Street Name Signing	3.6
3.2.7.	Guard Rail	3.7
3.2.8.	Medians	3.8
3.3.	Street Standards	3.8
3.3.1.	Street Arrangement	3.8
3.3.2.	Street Intersections	3.8
3.3.3.	Street Grades at Intersections	3.9
3.3.4.	Stub Streets	3.9
3.4.	Design Details	3.10
3.4.1.	General	3.10
3.4.2.	Subdivisions Along Existing Streets	3.10
3.4.3.	Subdivisions on Railroads	3.10
3.4.4.	Curbing Required	3.11
3.4.5.	Dedication of Streets	3.11
3.4.6.	Extraordinary Conditions	3.11
3.4.7.	Parking During Construction	3.11
3.4.8.	Flood Protection	3.11
3.4.9.	Tangents on Reverse Curves	3.11
3.4.10.	Vertical Curves	3.11
3.4.11.	Pavement Lugs for Rigid Pavement	3.12
3.4.12.	Sight Distance	3.12

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Paragraph	Title	Page
3.4.13.	Additional Right- Of -Way Obtained by City	3.12
3.4.14.	Entrance Landscaping and Monuments	3.13
3.4.15.	Existing Deficient Pavement in City Streets	3.13
3.4.16.	Longitudinal Joints and Striping	3.13
3.4.17.	Joint Sealing	3.13
3.4.18.	Collection of Stormwater Runoff	3.13
3.5.	Entrance Standards	3.13
3.5.1.	General	3.13
3.5.2.	Residential Entrances	3.13
3.5.3.	Commercial Entrances	3.14
3.5.4.	Left Turn Restrictions	3.16
3.5.5.	Entrance Clearance	3.16
3.5.6.	Temporary Emergency Access	3.16
3.5.7.	Cross Access	3.16
3.6.	Sidewalks and Handicap Ramps	3.17
3.7.	Curbs and Gutters	3.18
3.8.	Street Lighting	3.19
3.9.	Landscaping in the Right-of-Way	3.19
3.9.1.	General	3.19
3.9.2.	Location	3.19
3.9.3.	Ornamental Entrance Monuments and Signs	3.19
3.9.4.	Tree Lawn - Allowable Materials	3.20
3.9.5.	Hazardous Situations	3.21
3.9.6.	Inspection and Removal	3.21
3.9.7.	Other Landscaping Concerns	3.22
3.10.	Off-Street Parking and Loading	3.22
3.10.1.	Parking	3.22
3.10.2.	Loading	3.29
3.10.3.	Accessible Parking Space Requirements	3.29
3.11.	Geotechnical Report	3.30
3.12.	Other Requirements	3.32
3.12.1.	Noise Pollution	3.32
3.12.2.	Fire Station Signals	3.32
3.12.3.	Steep Grade Justification	3.32
3.12.4.	Retaining Walls	3.33
3.12.5.	Subgrade and Base Construction	3.33
3.12.6.	Backfill Under Pavements	3.35
3.12.7.	Blocks	3.35
3.12.8.	Underground Utility Lines	3.36

Paragraph	Title	Page
4.	WASTEWATER	4.1
4.1.	General	4.1
4.2.	Sewage Flow and Strength	4.1
4.2.1.	Population to be Served	4.1
4.2.2.	Sewage System Design Loadings	4.1
4.2.3.		4.1
4.3.	General Requirements for Sanitary Sewer Construction	4.1
4.3.1.	Size and Shape of Pipe	4.1
4.3.2.	Materials	4.1
4.3.3.	Gravity Pipe	4.1
4.3.4.	Pressure Pipe	4.3
4.3.5.	Trenching and Bedding	4.3
4.3.6.	Pipe or Conduit Under Streets and Pavements	4.3
4.3.7.	Joints	4.3
4.3.8.	Alignment	4.4
4.3.9.	Location	4.4
4.4.	Gravity Sewers	4.5
4.4.1.	Flowline	4.5
4.4.2.	Manholes	4.5
4.4.3.	Cleanouts	4.6
4.4.4.	Design Requirements	4.6
4.4.5.	Hydraulic Grade Line	4.7
4.4.6.	Infiltration	4.13
4.5.	Force Mains (Pressure Sewers)	4.13
4.5.1.	Materials	4.13
4.5.2.	Velocity	4.13
4.5.3.	Sewer Depth	4.13
4.5.4.	Cleanouts	4.13
4.5.5.	Air Relief Valves	4.14
4.5.6.	Termination	4.14
4.5.7.	Design Pressure	4.14
4.5.8.	Hydraulic Analysis	4.14
4.5.9.	Identification of Force Mains	4.15
4.6.	Sewage Treatment Facilities	4.15
4.7.	Special Situations and Design Requirements	4.15
4.7.1.	Connections to Manholes	4.15
4.7.2.	Adjusting Manholes to Grade	4.16
4.7.3.	Swimming Pools	4.16
4.7.4.	Channel Crossings	4.16
4.7.5.	Private Force Main Connections	4.16
4.7.6.	Storm Sewers Crossing Over Sanitary Sewers	4.16
4.7.7.	Location in Conjunction with Water Service	4.17
4.7.8.	Sanitary Sampling "T"	4.17

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Paragraph	Title	Page
4.7.9.	Abandonment of Sanitary Sewer Services	4.17
4.7.10.	Oil/Water Separators and Sand Filters	4.17
4.7.11.	Sanitary Detention Requirements	4.17
4.8.	Field Performance and Acceptance Tests	4.18
4.8.1.	Ball Test for Gravity Lines	4.18
4.8.2.	Visual Test for Gravity Lines	4.18
4.8.3.	Leakage Test for Force Mains	4.18
5.	STORMWATER	5.1
5.1.	General	5.1
5.2.	Stormwater Analysis	5.1
5.2.1.	Methods of Analysis	5.1
5.2.2.	Engineering Report Required	5.2
5.2.3.	Rainfall Frequency	5.2
5.2.4.	Rational Method	5.4
5.2.5.	Hydraulic Grade Line for Closed Conduits	5.9
5.2.6.	Hydraulic Grade Line for Open Channels	5.17
5.3.	General Requirements of Storm Sewer Construction	5.22
5.3.1.	Size and Shape	5.22
5.3.2.	Materials	5.22
5.3.3.	Bedding	5.22
5.3.4.	Pipe or Conduit	5.23
5.3.5.	Monolithic Structures	5.23
5.3.6.	Alignment	5.23
5.3.7.	Location	5.24
5.3.8.	Flowline	5.25
5.3.9.	Manholes	5.25
5.4.	Open Channels	5.26
5.4.1.	Channel Requirements	5.26
5.4.2.	Erosion Protection	5.28
5.4.3.	Sanitary Sewer Crossings	5.28
5.5.	Inlets	5.28
5.6.	Culverts	5.29
5.6.1.	General	5.29
5.6.2.	Hydraulic Design	5.30
5.6.3.	Entrances and Outlets, Headwalls and Endwalls	5.30
5.6.4.	Construction and Design	5.31
5.7.	Bridges	5.31
5.7.1.	MoDOT Criteria	5.31
5.7.2.	Waterway Capacity and Backwater Effects	5.31
5.7.3.	Clearance	5.31
5.7.4.	Waterway Alignment	5.31

INDEX

Paragraph	Title	Page
5.7.5.	Erosion Protection	5.31
5.8.	Outlet Erosion Protection	5.32
5.9.	Limitations on Areas Draining Across Sidewalks or Driveways	5.32
5.10.	Impervious Areas	5.32
5.11.	Stormwater Detention	5.32
5.11.1.	When Required	5.32
5.11.2.	Differential Runoff	5.32
5.11.3.	Design Considerations	5.32
5.11.4.	Maximum Depths	5.34
5.11.5.	Limits of Maximum Ponding	5.34
5.11.6.	Easement Required	5.35
5.11.7.	Maintenance Agreement	5.35
5.11.8.	Detention Basin Fencing	5.35
5.11.9.	Detention Basin Elevation	5.35
5.12.	Flood Plain Requirements	5.35
5.12.1.	Flood Plain Study	5.35
5.12.2.	Criteria for Preparation	5.36
5.12.3.	Filling in Flood Plain Areas	5.37
5.12.4.	Detention Basins in Flood Plains	5.37
5.12.5.	Bridges in Flood Plains	5.37
5.12.6.	Site Plan Requirements	5.37
6.	WATER SUPPLY	6.1
6.1.	General Requirements for Water Supply Systems	6.1
6.2.	Water Main Design	6.1
6.2.1.	Submittals	6.1
6.2.2.	Hydraulic Analysis	6.1
6.2.3.	Pressure	6.3
6.2.4.	Diameter	6.3
6.2.5.	Fire Protection	6.3
6.2.6.	Siting Requirements	6.3
6.2.7.	Dead Ends	6.4
6.3.	Water Supply Systems Materials and Construction	6.4
6.3.1.	General	6.4
6.3.2.	Site and Work Preparation	6.5
6.3.3.	Trenching and Excavation	6.5
6.3.4.	Pipe for Water Distribution Systems	6.6
6.3.5.	Pipe Installation	6.7
6.3.6.	Joints and Fittings	6.9
6.3.7.	Valves and Valve Boxes	6.10
6.3.8.	Fire and Flushing Hydrants	6.12
6.3.9.	Water Main Warning Tape	6.13
6.3.10.	Water Main Locator Wire	6.13

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Paragraph	Title	Page
6.3.11.	Thrust Blocking	6.14
6.3.12.	Pipe Encasement	6.14
6.3.13.	Connections to Present System	6.15
6.3.14.	Crossing Railroad, City Streets or State/County Highways	6.15
6.3.15.	Separation of Water Mains, Sanitary Sewers & Storm Sewers	6.16
6.3.16.	Surface Water Crossings	6.17
6.3.17.	Booster Pumps	6.18
6.3.18.	Testing Water Lines	6.18
6.3.19.	Flushing and Sterilizing Water Lines	6.19
6.3.20.	Handling of Materials	6.19
6.3.21.	Clean-Up	6.19
6.4.	Water Services	6.20
6.4.1.	Backflow Prevention	6.20
6.4.2.	Domestic Water Service Connections	6.21
6.4.3.	Industrial Water Service Connections	6.21
6.4.4.	Commercial Water Service Connections	6.21
6.4.5.	Own Meter	6.21
6.5.	Documentation Required	6.21
6.5.1.	Plans and Specifications Required	6.21
6.5.2.	Documentation to be Furnished to the City of Pacific	6.22
7.	RESERVED FOR FUTURE USE	
8.	MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTIONS	8.1
8.1.	Aggregates	8.1
8.1.1.	General Requirements	8.1
8.1.2.	Definition of Types of Aggregates	8.1
8.2.	Asphaltic Concrete	8.3
8.2.1.	Compositions of Mixtures	8.3
8.2.2.	Hauling Equipment	8.3
8.2.3.	Pavers	8.4
8.2.4.	Rollers	8.4
8.2.5.	Weather Limitations	8.4
8.2.6.	Spreading and Finishing	8.4
8.2.7.	Automatic Screed Control	8.5
8.2.8.	Compaction	8.6
8.2.9.	Joints	8.7
8.2.10.	Smoothness	8.8
8.3.	Portland Cement Concrete	8.8
8.3.1.	General	8.8
8.3.2.	Hauling	8.8
8.3.3.	Forms	8.9

INDEX

8.3.4.	Placing Concrete	8.11
8.3.5.	Vibrators	8.11
8.3.6.	Strike-Off of Concrete and Placement of Reinforcement	8.11
8.3.7.	Final Strike-Off, Consolidation, and Finishing	8.12
8.3.8.	Edging at Forms and Joints	8.13
8.3.9.	Joints	8.13
8.3.10.	Sealing Joints	8.14
8.3.11.	Curing	8.15
8.3.12.	Removing Forms	8.16
8.3.13.	Surface Test	8.16
8.3.14.	Opening to Traffic	8.16
8.3.15.	Slip-Form Construction	8.16
8.3.16.	Weather Limitations	8.18
8.4.	Reinforcing Steel	8.18
8.4.1.	General	8.18
8.4.2.	Welded Wire Fabric for Concrete Pavement	8.19
9.	STANDARD CONSTRUCTION DETAILS (See Standard Drawing List, page ix)	

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Number	Title	Page
List of Tables		
3-1	Arterial Street Design Criteria	3.1
3-2	Collector Street Design Criteria	3.2
3-3	Minor Street Design Criteria	3.3
3-4	Cul-de-Sac Design Criteria	3.4
3-5	Alley Design Criteria	3.5
3-6	Maximum Number of Commercial Entrances Allowed on Each Parcel or Site	3.15
3-7	Off-Street Parking Requirements	3.23
3-8	Required Parking Dimensions	3.25
3-9	Minimum Distance - Parking Lot Entrance to Street Intersection	3.26
3-10	Accessible Parking Space Requirements	3.29
4-1	Population to be Served	4.1
4-2	Sewage Flow and Strength Loading	4.2
4-3	Minimum Pipe Slopes, Gravity Sewer	4.6
4-4	Turn Loss Factors	4.9
5-1	24-Hour Storm Events	5.2
5-2	P Factor for Runoff	5.5
5-3A	P.I. Factors for Impervious Conditions (2 year and 5 year rainfall frequencies)	5.6
5-3B	P.I. Factors for Impervious Conditions (15 year and 20 year rainfall frequencies)	5.7
5-3C	P.I. Factors for Impervious Conditions (10 year and 100 year rainfall frequencies)	5.8
5-4	Loss in Turns	5.10
5-5	Head Loss Coefficients	5.19
6-1	Water System Design Factors - City of Pacific, Missouri	6.2
6-2	Minimum PVC Pipe Classes	6.7
6-3	Acceptable Gate Valve Models	6.10
6-4	Documentation to be Certified and Furnished by Developer	6.23
8-1	Asphaltic Concrete - Percent Passing by Weight	8.3
List of Figures		
5-1	Rainfall Intensity - Duration Curves	5.3
5-2	Head Loss In Curved Pipe	5.11
5-3	Transition Types for Rectangular Channels	5.20
5-4	Inlet and Gutter Capacity	5.30
Exhibits		
No.1	Cross Access Easement Agreement	3.37

STANDARD DRAWING LIST

Dwg. No.	Title	Page
Streets and Parking		
STR.01 Sh1	Standard Typical Section, Arterial 80' R/W, 50' Pavement.	
Sh2	Standard Typical Section, Arterial 80' R/W, 50' Pavement.	
STR.02 Sh1	Standard Typical Section, Collector 60' R/W, 40' Pavement.	
Sh2	Standard Typical Section, Collector 60' R/W, 40' Pavement.	
STR.03 Sh1	Standard Typical Section, Minor 50' R/W.	
Sh2	Standard Typical Section, Minor 50' R/W.	
STR.12 Sh1	Cul-de-Sac Detail	
STR.12 Sh2	Cul-de-Sac Detail	
STR.16	Typical Intersection Details, Sidewalks, Street Names, Signs and Monuments	
STR.17	Pavement Construction Details, Concrete Sidewalk and Handicap Ramps	
STR.18	Street Name Signs, Details and Locations	
STR.19 Sh1	Sight Distance at Intersection	
STR.19 Sh2	Sight Distance at Intersection	
STR.20	Entrance Construction Details, Street Intersection Platform	
STR.21	Entrance Construction Details, Residential Concrete Entrances	
STR.22	Residential Entrance Clearance	
STR.23	Entrance Construction Details, Commercial Concrete Entrances	
STR.24	Entrance Construction Details, Commercial Entrance Clearance	
STR.25	Integral Vertical Curb and Concrete Pavement, Typical Section and Detail	
STR.40	Recommended Design Control for Vertical Curves	
STR.60	Pavement Construction Details, Dowel Supporting Units Approved for Use With Transverse Joints	
STR.70	Pavement Construction Details, Joints and Curbs	
STR.75 Sh1	Pavement Construction Details, Pavement Lug	
STR.75 Sh2	Pavement Construction Details, Pavement Lug	
STR.76	Pavement Construction Details, 6" Raised Doweled-On Concrete Median	
STR.77	Intersection Channelization Details, Right In - Right Out Channelized Street or Commercial Entrance	
STR.80	Pavement Construction Details, Class A Underdrains	
STR.90	Typical Undergrading Details	
Pipe		
PIP.01	Pipe Trenching and Bedding Details	
PIP.02	Concrete Cradle	
PIP.03	Concrete Encasement	
PIP.04	Typical Service Connection	
PIP.05	House Connection to Existing Tee or Wye	

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Dwg. No.	Title	Page
PIP.06	House Connections Allowed by Tee Saddle	
PIP.07	Machine Tap	
PIP.08	8" (& Larger) Connection to Plastic Main	
PIP.09	Culvert Installation Methods	
Manholes & Cleanouts		
MH.01	Pre-Cast Concrete Manhole for Sewers	
MH.02	Inside Foulwater Drop Manhole	
MH.03	Inside Foulwater Drop Manhole (for Free-Fall)	
MH.04	Outside Foulwater Drop Manhole	
MH.06 Sh1	Typical Force Main Clean-out Elevation View	
MH.06 Sh2	Typical Force Main Clean-out Plan View	
MH.07	Cast Iron Manhole Frame	
MH.08	Cast Iron Covers, Manhole and Inlet	
MH.09	Gravity Sewer Cleanout Detail	
Stormwater		
SW.02	Area Inlet Manhole	
SW.03	Pre-Cast Concrete Unit for Street Double Inlet	
SW.04	Trapped Street Inlet	
SW.05	House Connection to Existing Tee or Wye	
SW.06	Area Inlet Top	
SW.07	Pre-Cast Curb Inlet	
SW.08	2 Grate Inlet Side Intake Unit	
SW.09	2 Grate Inlet Top	
SW.10	Detail of Steel Grate	
SW.11	Cast Iron Side Intake Unit for Grated Inlets	
SW.12	Sewer Construction Details, Grates and Bearing Plates	
SW.18 Sh1	Sewer Construction Details, Street Inlet Sumps	
SW.18 Sh2	Sewer Construction Details, Street Inlet Sumps	
SW.18 Sh3	Sewer Construction Details, Street Inlet Sumps	
SW.18 Sh4	Sewer Construction Details, Street Inlet Sumps	
SW.19	Flared End Section	
SW.20	Rock Lining for Culvert Outlet	
SW.21	Flared End Section (Precast Concrete)	
SW.22	Paved Ditches and Gutters	
SW.23	Rock Ditch Liner	
SW.24 Sh1	Culvert Installation Methods	
SW.24 Sh2	Culvert Installation Methods	
SW.25	Tongue & Groove Concrete Pipe Joint	
SW.26	Sewer Construction Details, Pipe Collars	
SW.27	Flared End Section (Metal)	

STANDARD DRAWING LIST

Dwg. No.	Title	Page
Water Supply		
WS.02 Sh1	Fire Hydrant and Setting Back of Curb, Connection to New Water Main	
WS.02 Sh2	Fire Hydrant and Setting Back of Curb, Connection to Existing Water Main	
WS.03	Typical Installation of ¾" Metered Domestic Service	
WS.04	Water & Sewer Mains Crossing Detail	
WS.05	Thrust Anchorage Criteria	
WS.06	Industrial Service Connection, Meter in Vault, 2" through 6" Diameter	
WS.07	Types of Thrust Blocks	
Miscellaneous Details		
MD.06	Staple Placement for Plastic Netting	
MD.07	Siltation Control Devices	
MD.08 Sh1	Temporary Erosion Control Measures	
MD.08 Sh2	Temporary Erosion Control Measures	
MD.08 Sh3	Temporary Erosion Control Measures	
MD.08 Sh4	Temporary Erosion Control Measures	
MD.08 Sh5	Temporary Erosion Control Measures	

SECTION 1

INTRODUCTION

1.1 PURPOSE. The purpose of these standards is to provide a consistent set of design criteria and methods for all land development & construction work in the City of Pacific, Missouri. It is intended to be used by engineers, developers, contractors and City workmen in the design, construction, and maintenance of all private developments and public works projects undertaken in the City. It is also to be used by the Department of Public Works and the Building Department in plan review and construction inspection. Adherence to these Standards will expedite review and approval of plans. Any departure from these design requirements should be brought to the attention of the Department of Public Works and discussed before submission of plans for approval, and should be justified.

1.2 AUTHORITY. Issuance for all specifications and procedures for design and construction of all public works improvements is at the direction and control of the Commissioner of Public Works (Pacific City Code, Title I, Article VI).

1.3 DISCUSSION

1.3.1 The long-term effect of the use of these Standards will be to promote the general welfare and minimize cost to the citizens and government agencies of the City of Pacific. Through the practice of good designs that are built of good materials and properly installed the overall cost of construction and maintenance are kept to a minimum. Standardization is also economically sound because of cost benefits to be realized by quantity material purchases, workmen and contractors who are familiar with the details and construction methods and maintenance personnel who know how to operate and maintain the items. In addition, there is a beneficial aesthetic effect to be realized by having uniformity in details of the City's infrastructure, e.g. curbing, street signs, sidewalk, manhole covers, etc.

1.3.2 In developing these Standards, the City of Pacific wishes to acknowledge the contributions made by the Missouri Department of Transportation, Missouri Department of Natural Resources, St. Louis County and the Metropolitan Sewer District of St. Louis whose own design standards were liberally drawn upon. These Standards were used as the basis of the Pacific Standards because they have been used successfully for a number of years and have withstood the test of time. Many represent the state-of-the art in construction technology. Another advantage is that contractors in the area are familiar with their requirements and have been building to them for a number of years. That a quality product can be built from them is a certainty. It is also possible to develop reliable construction cost estimates from them for use in contracting and in issuing permits where a bond or escrow is required.

1.3.3 It is not the intent of the City of Pacific to inhibit innovation by issuing these Standards for Improvements. This set of Standards is meant to be a living document. Changes will most certainly be issued over time as technology, materials and construction methods improve. The City welcomes suggestions from anyone knowledgeable in the subject and proposals on different materials and methods will be accepted at any time. It is requested that the proposer submit his suggestions, with supporting documentation demonstrating equivalency or improvement, to the Commissioner of Public Works.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

1.4 ORGANIZATION. These Standards cover most areas that come up in normal municipal development. The Standards are organized into five major areas, not including this introduction.

They are:

- Section 2. Definitions
- Section 3. Streets and Parking
- Section 4. Wastewater
- Section 5. Stormwater
- Section 6. Water Supply
- Section 7. Reserved for Future Use
- Section 8. Material Specifications and Placement Instructions
- Section 9. Standard Details

Questions on content, or on specialty items not covered, should be directed to the Commissioner of Public Works, City of Pacific, Missouri.

SECTION 2
DEFINITIONS

2. DEFINITIONS

2.1. DEFINITIONS. In addition to words and terms that may be defined elsewhere in this manual, the following words and terms shall have the meanings defined below:

AASHTO: American Association of State Highway and Transportation Officials.

Alley: A secondary means of ingress and egress serving more than one tract of land and used primarily for vehicular service, and which may be used for public utility purposes. Alleys are not maintained by the Department and are normally located adjacent to the rear property lines.

Allowable Release Rate: The pre-development or existing condition peak flow corresponding to a selected rainfall frequency event.

ANSI: American National Standards Institute.

Applicant: The government agency, utility company, contractor, developer or individual seeking permission to work within the City of Pacific, Missouri.

Architect: A professional architect registered in the State of Missouri.

AWWA: American Water Works Association.

Backfill: The material used to fill an excavation.

Base Flood: The flood having a one (1) per cent chance of being equaled or exceeded in any given year. The base flood, adopted by the Federal Emergency Management Agency (FEMA), is the 100 year flood.

Basement: The lowest level or story of a structure which has its floor below grade on all sides.

Bedding: The material on which the pipe or conduit is supported and protected.

Bench Mark: A definite point of known elevation and location and of more or less permanent character. The identity and elevation shall be based on United States Geological Survey (U.S.G.S.) Datum or bench marks established by FEMA. Temporary bench marks for a project shall be established from, and tied to, either system.

Biochemical Oxygen Demand (BOD): The quantity of oxygen utilized in the biochemical oxidation of organic matter in 5 days as determined by Standard Methods and expressed in milligrams per liter.

Block: An area of land surrounded by public highways, streets, streams, railroad rights-of-way, parks, rural land, drainage channels or other similar areas or facilities.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Bonding Agent: A qualified surety or sureties, licensed to do business in the State of Missouri, who issues a site plan or other bond.

Bridge: A structure having a clear span greater than 20 feet measured on a horizontal plane along the centerline of the roadway; also a multiple span structure where the total length of span is in excess of 20 feet. For both a single and multiple span bridge, the clear span shall be construed to mean the total distance from stream face to stream face of end bents or outer walls of structure

Building Line (Setback): A line or lines on a plat designating the area outside of which buildings may not be erected, except landings, open balconies and roof overhangs, as permitted in the Zoning and Subdivision Ordinance.

Building Structure: Walled or roofed building that is principally above ground, as well as a manufactured home.

Channel: A natural or artificial water course.

City: The City of Pacific, Missouri

Commission: The Planning and Zoning Commission of the City of Pacific.

Commissioner: The Commissioner of Public Works of the City of Pacific, Missouri

Common Land: The land set aside for open space including stormwater, retention lakes, ponding or recreational use for the owners of residential lots in a subdivision. This land is conveyed by the developer in fee simple absolute title by a warranty deed to the Trustees. The trust indenture for common land shall provide that it be used for the sole benefit, use and enjoyment of the lot owners present and future and shall be the maintenance responsibility of the trustees of the subdivision. No lot owner shall have the right to convey his interest in common land except as an incident of his ownership of a regularly platted lot.

Construction Cost Index: An annual analysis which measures the effects of wage rate and material price trends. These indexes are developed on a 1913=100 base. The percent change of the construction cost index from December of a given year to December of the following year as published in the Engineering News Record is used to inflate trust fund rates.

Cross Access: A commonly shared or used private pedestrian way or vehicular driveway that internally connects or serves two or more adjacent properties.

Crushed Stone: The product obtained by the artificial reduction in the size of rock which has been mined or excavated from ledge formation. Chat is not included in this definition.

2. DEFINITIONS

Culvert: A closed conduit for the free passage of surface drainage water under a highway, railroad, or other embankment.

Curve, Long: A curve having a centerline radius equal to or greater than fifty (50) feet.

Curve, Short: A curve having a centerline radius of less than fifty (50) feet.

Dedication: The process by which the owner gives approved streets, sewers, water systems and other facilities to the City for public use and maintenance.

Department: The Department of Public Works of the City of Pacific, Missouri

Design Speed: On arterial and collector streets, the design speed shall be 5 m.p.h. greater than the posted or the anticipated posted speed limit. For minor streets and cul-de-sacs the design speed shall be the posted or the anticipated posted speed limit.

Detention: (See Sanitary Detention, Stormwater Detention)

Developer: The person, firm or corporation who develops and improves a tract pursuant to the requirements of these Standards and the Subdivision and Zoning Ordinances.

Developed Runoff Rate: The peak flow corresponding to a selected rainfall event as a result of developed site conditions.

Development: The act of changing and the state of a tract of land after its function has been purposefully changed by man including, but not limited to, structures on the land and alterations to the land.

Differential Runoff: The difference in rate and volume of stormwater runoff from a parcel or project between the pre-developed runoff rate and the developed runoff rate.

Drainage Facility: Any system of artificially constructed drains, including open channels and sewers used to convey stormwater, surface or groundwater, either continuously or intermittently to natural watercourses.

Driveway: A privately maintained travelway used for vehicular access to a site and distribution within a site, not including sidewalks.

Driveway, Common (Party): A single driveway providing vehicular access to two adjoining properties.

Drop: A structural configuration where flow falls into a structure from an incoming pipe.

Easement: A grant by a property owner to the public, a corporation, or a person, for the use of land for a specific purpose.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Easement, Cross Access: A designated private access way for the servicing of aisles or driveways that internally connect two or more properties.

Easement, Permanent Drainage: A grant by a property owner to the City for the purpose of improving, constructing, repairing and maintaining drainage structures.

Easement, Permanent Roadway Improvement: A grant by a property owner to the City for the purpose of improving, constructing, repairing and maintaining roadway improvements.

Easement, Permanent Sidewalk, Sewer and/or Utility: A grant by a property owner to the City for the purpose of improving, constructing, repairing and maintaining sidewalks, sewers and utilities.

Easement, Permanent Sight Distance: A grant by a property owner to the City for the purpose of controlling and directing grading and the installation and maintenance of plant material, trees and/or structures by the property owner in a manner that will provide and insure sight distance for motorists as required by the City.

Easement, Permanent Stormwater Control: A grant by a property owner to the City for the purpose of improving, constructing, repairing and maintaining stormwater drainage facilities.

Easement, Permanent Stormwater Control Access: A grant by a property owner to the City to provide for access and upkeep of the area within designated stormwater control easements.

Easement, Permanent Utility: A grant by a property owner to a public or private utility company for the purpose of improving, constructing, repairing and maintaining utilities.

Easement, Private Roadway: A designated private access way for the servicing of individual lots within a subdivision.

Easement, Temporary Construction: A grant by a property owner to the City for the purpose of making cuts, fills and sloping embankments, constructing driveways, providing working room and implementing any and all other related construction items in connection with an improvement.

Engineer: A professional engineer registered in the State of Missouri.

Entrance, Commercial: A driveway providing ingress and egress for a commercial site.

Entrance, Residential: A driveway providing ingress and egress for a residential site.

FEMA: the Federal Emergency Management Agency.

2. DEFINITIONS

Finish Elevation: The proposed elevation of the land surface of a site after completion of all site preparation work.

Finished Grade: The final elevation of the ground surface after development.

Flood Insurance Study: The Official Report provided by the Federal Emergency Management Agency containing flood profiles, flood boundaries, floodway maps and the water surface elevation of the base flood.

Flood Plain: A geographic area susceptible to periodic inundation from the overflow of natural waterways during the base (100 year) flood. It is determined as to extent in the City of Pacific by the current FEMA Flood Insurance Studies for the City of Pacific, Franklin County and St. Louis County, Missouri-Unincorporated Areas, with accompanying Flood Insurance Rate Maps and Flood Boundary and Floodway Maps.

Flood Plain Study: An Engineering analysis to determine the hydraulic effect, if any, of the proposed development to the existing Flood Plain.

Floodway: The area designated as Floodway on the Federal Emergency Management Agency Flood Boundary and Floodway Maps. It is derived by determining that portion of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

Floodway Fringe: That area of the 100 year Flood Plain excluding the floodway is known as the floodway fringe. It is also that portion of the 100 year Flood Plain which can be developed without cumulatively raising the base flood elevation more than one foot.

Force Main: A pressurized sewer carrying wastewater.

Freeboard: The difference in elevation between the hydraulic grade line elevation and (1) the inlet sill elevation; or (2) the top of structure elevation; or (3) the top of channel bank elevation; or (4) the top of wall elevation.

Frontage: The edge of a lot bordering a street.

Geotechnical Report: A report, signed and sealed by a registered geotechnical engineer, used to determine extent of development and grading, slope stability in the form of maximum slopes, sink hole conditions, need for interceptor ditches and any items that may affect the extent of development and/or location of structures on the site.

Grade: The rate of deviation from horizontal, expressed in percentages (i.e., 2%, 3%, etc.).

Gravel: The coarse granular material (generally considered as material retained on the No. 4 or No. 10 sieve but may include finer sizes) resulting from the natural disintegration and

PACIFIC DESIGN & CONSTRUCTION STANDARDS

abrasion of rock or from processing of weakly bound conglomerate. It may include such material which has been further reduced in size by artificial means.

House Lateral: Private sewer from building drain to the public sewer.

HS 10: Live truck wheel loads as designated by the AASHTO Specifications.

HS 20: Live truck wheel loads as designated by the AASHTO Specifications.

Hydraulic Grade Line: A line coinciding with the level of flowing water at any given point along an open channel; or the level to which water would rise in a vertical tube connected to any point along a pipe or closed conduit flowing under pressure.

Inlet Time: The overland flow time for runoff to reach the inlet.

Intrados: The inside top of the sewer pipe.

Land Surveyor: A professional land surveyor registered in the State of Missouri.

Lateral Sewer: A sewer that discharges into a branch or other sewer and has no other common sewer tributary to it.

Loading Space: A durably dustproofed, properly graded for drainage, off-street space used for the loading and unloading of vehicles, except passenger vehicles, in connection with the use of the property on which such space is located. Off-street parking and loading requirements shall be located to avoid any maneuvering on public streets and roadways.

Low Sill: The lowest elevation of any opening in a building.

Lot: An area of land which is part of a subdivision, the plat of which has been legally approved and recorded in the Office of the Recorder of Deeds of Franklin County or St. Louis County, as applicable, and is intended to be separately owned, developed or otherwise used as a unit or an area of land.

Lot Area: The total horizontal area within the boundaries of a lot exclusive of any area designated for street purposes.

Lot, Corner: A platted area of land abutting two street rights-of-way at their intersection.

Lot, Double Frontage: A lot having frontage on two (2) nonintersecting streets, as distinguished from a corner lot.

Lot (Parcel) of Record: A lot which is part of a subdivision, the plat of which has been legally approved and recorded in the Office of the Recorder of Deeds of Franklin County or St. Louis County, as applicable, or a parcel of land which was legally approved and the deed

2. DEFINITIONS

recorded in the Office of the Recorder of Deeds of Franklin County or St. Louis County, as applicable.

Main Sewer: The principal sewer to which branch sewers and sub mains are tributary; also called trunk sewer.

MDNR: The Missouri Department of Natural Resources

MoDOT: The Missouri Department of Transportation

Monument: A marker generally defining land boundaries or elevations placed by a land surveyor at locations specified in Section 400.170(4)(C) of the Zoning and Subdivision Ordinance of the City and/or as directed by the Department.

"n" Value: A dimensionless coefficient used in Manning's Equation to account for frictional losses in steady uniform flow.

On-Street Parking Space: A temporary storage area for a motor vehicle which is located on a dedicated street right-of-way.

Ordinance: Any Ordinance duly adopted by the City

Outfall: The point location or structure where wastewater or drainage discharges.

Parcel (Tract) of Land: A separately designated area of land delineated by identifiable legally recorded boundary lines.

Parking Bay: A paved vehicle storage area directly adjacent to the access street or privately controlled pavement.

Parking Space: A durably dustproofed, properly graded for drainage, usable space, enclosed in a main building or in an accessory building, or unenclosed, reserved for the temporary storage of one vehicle, and connected to a street, alley, or other designated roadway by a surfaced aisle or driveway.

Pave (Pavement): The act or result of applying a hard, water-tight material to any ground surface in such manner as to present a uniform surface over large areas.

Pedestrian Way: An easement or right-of-way designated to facilitate pedestrian access to adjacent streets and properties.

Person: Any individual, firm, proprietorship, partnership, company, municipality, association, society, corporation, group, or other entity.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Plan, Concept: A drawing showing the site, internal circulation, adjacent public roads and commercial and residential entrances. Such plans must also show the dimensions and lane use of the existing public roadways.

Plan, Site: A drawing showing plan and section views of the existing conditions and proposed improvements.

Plans, Construction: Same as Plans, Improvement.

Plans, Improvement: The engineering drawings showing the construction details and the types of materials for the physical structures and facilities, excluding dwelling units, to be installed in conjunction with the development of the project.

Plat: A subdivision of land legally approved and recorded.

Pre-Developed Runoff Rate: The amount of flow from an existing site prior to new development or improvements.

Prismatic Channel: A channel characterized by uniform cross sections and constant bottom slope.

Private Sewer: A sewer not accepted for public maintenance as determined by the reviewing agency.

Property Line: The legally recorded boundary of a lot, tract, or other parcel of land.

Public Sewer: A sewer which has been accepted for public maintenance by the City

Reach: A distance, in a pipe or channel, between two identified points.

Record Subdivision Plat: That plat containing all signatures required by Section 410.050(2) of the Zoning and Subdivision Ordinances and recorded in the Office of the Recorder of Deeds of Franklin County or St. Louis County, as applicable.

Right-of-way: A strip of land reserved or acquired by dedication, prescription, condemnation, gift, purchase, eminent domain or any other legal means, occupied or intended to be occupied by a street, sidewalk, railroad, utility, sewer, or other similar use.

Road: Same as Street.

Roadway: The entire area within public or private vehicular easement or right-of-way lines, whether improved or unimproved.

Sampling "T": A riser section installed in the house lateral for purposes of monitoring sewage discharged.

2. DEFINITIONS

Sanitary Detention: An "On Site" private facility to collect and store the sanitary wastewater of a development for such time as may be required until it can be pumped or otherwise discharged into the downstream sanitary sewer system.

Sanitary Sewer: A sewer which carries wastewater.

Setback (Building Line): The required minimum distance from a road right-of-way or lot line that establishes the area within which a structure can be erected or placed, except as may be permitted in the Zoning and Subdivision Ordinance.

Sewer: A pipe or closed conduit carrying wastewater, stormwater or a combination thereof.

Sight Distance Triangle: The triangular area of a street intersection bounded by the property lines of a corner lot and a line connecting two (2) points on the property lines, each measured thirty (30) feet from the intersection of the two property lines at the street intersection. Where applicable, easement lines shall be substituted for property lines.

Sign, Guide: A sign identifying entrances, exits, aisles, ramps, and similar traffic related information.

Siltation Control: The installation of such devices as sediment ponds, bales of straw, siltation fencing, sodding or seeding and mulching, or other devices to prevent silting of abutting properties and roadway during the period of construction and up to and including such time as permanent ground cover is attained.

Single Lot Development: A development consisting of one or more buildings to be erected on a platted parcel of land or a single lot which is part of a subdivision, intended to be separately owned, developed, and otherwise used as a unit.

Site Plan Bond: A bond or other security between the developer and the City to cover the cost of completion of required on-site improvements as depicted upon approved construction improvement plans.

Slope: The rate of deviation of the ground surface from the horizontal surface, expressed in percentages or proportions (i.e., 3 horizontal: 1 vertical, 4 horizontal : 1 vertical, etc.).

Springline: The line or plane in which an arch rises from its impost. In circular conduits, the horizontal plane through the midpoint of the section.

Standard Details of Sewer Construction: Plans of structures or devices or construction details commonly used on City work and referred to on the plans or in the specifications.

Steady Flow: The quantity of water passing a cross section is constant, i.e., has patterns and magnitudes which do not vary with time.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Steep Grade: Roadway grades in excess of 8%.

Stormwater Detention: A stormwater runoff facility designed to detain (hold) stormwater temporarily during and immediately after a runoff event.

Stormwater Sewer: A sewer which carries surface runoff and subsurface waters.

Street: A public or private thoroughfare which affords the principal means of access to abutting property, including all facilities which normally occur within the right-of-way. The term shall also include such other designations as highway, thoroughfare, parkway, throughway, road, pike, avenue, boulevard, lane, place, court, but shall not include an alley or a pedestrian way. The pavement requirements for private streets shall be the same as public streets except that special roadway sections may be used for drainage and perpendicular parking.

Street, Arterial: A major street so designated by the, and utilized primarily for heavy volumes of traffic on a continuous route or for high vehicular speeds with intersections at grade.

Street, Collector: A secondary land service street that moves traffic from the arterial streets, and distributes traffic regionally, to the minor streets. Collector streets also may serve individual lots, parcels, and uses as a secondary or additional function.

Street, Cul-de-Sac: A short, independent, minor street terminating in a circular turnaround.

Street, Dead End (No Outlet): A street having only one point of ingress and egress.

Street, Minor: A land service facility for access to abutting properties. Minor streets serve the local neighborhood and are frequently in the form of a cul-de-sac or loop street.

Street, Private: A privately maintained thoroughfare which affords the principal means of public access to abutting property and which is constructed within easements provided by adjacent property owners.

Street, Public: A street maintained by the Department.

Structure: Any assembly of material forming a construction for occupancy or use, excepting, however, utility poles and appurtenances thereto, underground distribution or collection pipes or cables, and underground or ground level appurtenances thereto.

Swale: A broad, shallow water course.

Time of Concentration: Consists of inlet time plus the travel time in the sewer or channel from the most remote point in the watershed to the point under consideration.

2. DEFINITIONS

Travel Time: The time it takes for the runoff to flow through the drainage system from one point of reference to the next point of reference.

Trunk Sewer: The principal sewer to which branch sewers and sub-trunks are tributary; also called main sewers.

Uniform Flow: The flow in a channel, conduit or pipe, having a uniform cross section and velocity at every location within a given reach.

U.S.G.S.: United States Geological Survey

Utilities: Public service facilities for supplying gas, electricity, water, power, steam, cable TV, telephone and telegraph communication, railway transportation, and the like. Sewers are not considered utilities.

Wastewater: The spent water of a community.

Watercourse: A stream of water or a natural channel through which water may flow.

SECTION 3
STREETS AND PARKING

3. STREETS & PARKING

3.1. STREET DESIGN CRITERIA

3.1.1. Arterial Streets. Arterial streets shall conform to the minimum design criteria in Table 3-1:

Table 3-1
Arterial Street Design Criteria

Item	Minimum Requirement
Right-of-way Width	80 ft.
Pavement Width*	50 ft.
Full Depth Asphalt Wearing Surface Base Course	2" Type C Asphaltic Concrete 8" Type X Asphaltic Concrete
Rigid Pavement (Concrete) Pavement Compressive Strength Reinforcement Transverse Joints Base	8" Portland Cement Concrete 4,000 p.s.i. 6 x 6, 4/4 Welded Wire Mesh STR.70 Type G and sealed per 3.4.17 4" of Type 1 aggregate, compacted
Asphalt Pavement With Rock Base Wearing Surface Base Course	3" Type C Asphaltic Concrete 2" of Type 2 aggregate, compacted over 10" of Type 1 aggregate, compacted
Sub-grade	Undergrade per STR.90. Compact to 95% Standard Proctor density
Grades, Maximum**	10%
Horizontal Curvature Along the Centerline	500 ft. Radius
Horizontal Visibility Along the Centerline	500 ft.
Curb***	6" vertical concrete
Sidewalk	4 ft. wide - concrete
Tree lawn	11 ft.
Standard Drawing Number	STR.01
Anticipated Posted Speed Limit	45 MPH
* Measured back-to-back of curb. ** Maximum grades in the R1-H zoning district shall be 15%. Any variance shall be recommended by the Commissioner and approved by the Board of Aldermen. *** A 4-inch high rolled curb may be used in subdivisions exclusively for single family residences, as approved by the Commissioner.	

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.1.2. Collector Streets. Collector streets shall conform to the minimum design criteria in Table 3-2:

**Table 3-2
Collector Street Design Criteria**

Item	Minimum Requirement
Right-of-way Width	60 ft.
Pavement Width*	40 ft.
Full Depth Asphalt Wearing Surface Base Course	2" Type C Asphaltic Concrete 7" Type X Asphaltic Concrete
Rigid Pavement (Concrete) Pavement Compressive Strength Transverse Joints Base	8" Portland Cement Concrete 4,000 p.s.i. STR.70 Type G and sealed per 3.4.17 4" of Type 1 aggregate, compacted
Asphalt Pavement With Rock Base Wearing Surface Base Course	3" Type C Asphaltic Concrete 2" of Type 2 aggregate, compacted over 9" of Type 1 aggregate, compacted
Sub-grade	Undergrade per STR.90. Compact to 95% Standard Proctor density
Grades, Maximum**	10%
Horizontal Curvature Along the Centerline	300 ft. Radius
Horizontal Visibility along the Centerline	300 ft.
Curb***	6" vertical concrete
Sidewalk	4 ft. wide - concrete
Tree lawn	6 ft.
Standard Drawing Number	STR.02
Anticipated Posted Speed Limit	35 MPH
* Measured back-to-back of curb. ** Maximum grades in the R1-H zoning district shall be 15%. Any variance shall be recommended by the Commissioner and approved by the Board of Aldermen. *** A 4-inch high rolled curb may be used in subdivisions exclusively for single family residences, as approved by the Commissioner.	

3. STREETS & PARKING

3.1.3. Minor Streets.

3.1.3.1 Minor streets shall conform to the minimum design criteria in Table 3-3:

**Table 3-3
Minor Street Design Criteria**

Item	Minimum Requirement
Right-of-way Width	50 ft.
Pavement Width*, Normal	32 ft.
Pavement Width*, Subdivisions which contain lots exclusively for single family residences	30 ft.
Full Depth Asphalt Wearing Surface Base Course	2" Type C Asphaltic Concrete 6" Type X Asphaltic Concrete
Rigid Pavement (Concrete) Pavement Compressive Strength Transverse Joints Base	7" Portland Cement Concrete 4,000 p.s.i. STR.70 Type G and sealed per 3.4.17 4" of Type 1 aggregate, compacted
Asphalt Pavement With Rock Base Wearing Surface Base Course ♦	3" Type C Asphaltic Concrete 2" of Type 2 aggregate, compacted over 8" of Type 1 aggregate, compacted
Sub-grade	Undergrade per STR.90. Compact to 95% Standard Proctor density
Grades, Maximum**	10%
Horizontal Curvature Along the Centerline	150 ft. Radius
Horizontal Visibility along the Centerline	150 ft.
Curb***	6" vertical concrete
Sidewalk	4 ft. wide - concrete
Tree lawn	If pavement width = 32 ft., tree lawn = 5 ft. If pavement width = 30 ft., tree lawn = 6 ft.
Standard Drawing Number	STR.03
Anticipated Posted Speed Limit	30 MPH
* Measured back-to-back of curb. ** Maximum grades in the R1-H zoning district shall be 15%. Any variance shall be recommended by the Commissioner and approved by the Board of Aldermen. *** A 4-inch high rolled curb may be used in subdivisions exclusively for single family residences, as approved by the Commissioner. ♦ Aggregate base in parking lots to be 8" of Type 1 aggregate, compacted, with all other materials remaining the same.	

3.1.3.2 Minor streets shall be designed so as to discourage through traffic.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.1.4. Cul-de-Sacs

3.1.4.1 Cul-de-Sacs shall conform to the minimum design criteria in Table 3-4:

**Table 3-4
Cul-de-Sac Design Criteria**

Item	Minimum Requirement
Right-of-way Width [#]	46 ft.
Right-of-way Width ^{##}	50 ft.
Right-of-way Diameter at turn-around	100 ft.
Pavement Width [#] *	26 ft.
Pavement Width ^{##} * ♦	32 ft.
Pavement Radius at turn-around*	41 ft.
Full Depth Asphalt Wearing Surface Base Course	2" Type C Asphaltic Concrete 6" Type X Asphaltic Concrete
Rigid Pavement (Concrete) Pavement Compressive Strength Transverse Joints Base	7" Portland Cement Concrete 4,000 p.s.i. STR.70 Type G and sealed per 3.4.17 4" of Type 1 aggregate, compacted
Asphalt Pavement With Rock Base Wearing Surface Base Course	3" Type C Asphaltic Concrete 2" of Type 2 aggregate, compacted over 8" of Type 1 aggregate, compacted
Sub-grade	Undergrade per STR.90. Compact to 95% Standard Proctor density
Grades, Maximum**	10%
Horizontal Curvature Along the Centerline	150 ft. Radius
Horizontal Visibility along the Centerline	150 ft.
Maximum length	900 ft.***
Curb****	6" vertical concrete
Sidewalk	4 ft. wide - concrete
Tree lawn	If Right-of-way = 46 ft, tree lawn = 6 ft. If Right-of-way = 50 ft, tree lawn = 5 ft. At turn-around, tree lawn = 5 ft.
Standard Drawing Number	STR.12
Anticipated Posted Speed Limit	25 MPH
[#] Cul-de-sacs less than 450 ft. in length. ^{##} Cul-de-sacs 450 ft. in length or greater. * Measured back-to-back of curb. ** Maximum grades in the R1-H zoning district shall be 15%. Any variance shall be recommended by the Commissioner and approved by the Board of Aldermen. *** As measured from the nearest intersecting street to the furthest point of the turn-around. **** A 4-inch high rolled curb may be used in subdivisions exclusively for single family residences, as approved by the Commissioner. ♦ Pavement width may be reduced to 30 ft. if cul-de-sac serves single family residences exclusively.	

3. STREETS & PARKING

3.1.4.2 Block design shall be limited to nine hundred (900) feet in length as measured from the nearest intersecting street to the furthest point of the turn-around.

3.1.5. Alleys.

3.1.5.1 Alleys shall conform to the minimum design criteria in Table 3-5:

**Table 3-5
Alley Design Criteria**

Item	Minimum Requirement
Right-of-way Width	20 ft.
Pavement Width	16 ft.
Full Depth Asphalt Wearing Surface Base Course	2" Type C Asphaltic Concrete 6" Type X Asphaltic Concrete
Rigid Pavement (Concrete) Pavement Compressive Strength Transverse Joints Base	6" Portland Cement Concrete 4,000 p.s.i. Type G & sealed per 3.4.17 4" of Type 1 aggregate, compacted
Asphalt Pavement With Rock Base Wearing Surface Base Course	3" Type C Asphaltic Concrete 2" of Type 2 aggregate, compacted over 6" of Type 1 aggregate, compacted
Sub-grade	Compacted to 95% Standard Proctor density
Grades, Maximum*	10%
Centerline: Alignment	15°
Radius of Curvature	375 ft.
Horizontal Visibility along the Centerline	150 ft.
* Maximum grades in the R1-H zoning district shall be 15%. Any variance shall be recommended by the Commission and approved by the Board of Aldermen.	

3.1.5.2 Alleys are prohibited in all residential districts but may be included in commercial and industrial districts where needed for loading, unloading, or access purposes. Use of alleys shall be approved by the Commission.

3.2. STREET IMPROVEMENTS

3.2.1 Grading and Surfacing Required

3.2.1.1 All streets shall be graded and the roadway improved by surfacing. Roadway design, construction, and surfacing shall be in accordance with City of Pacific Code, standards and specifications.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.2.1.2 All grading and surfacing shall be done under observation and inspection of the Department and shall be subject to its approval. Notification/request for inspection shall be made to the Commissioner of Public Works at least three (3) hours prior to the commencement of any of the following activities or as directed by the Commissioner: including but not limited to backfilling of any cut or trench excavation, placing any base or pavement for roadways, curb and gutter, or sidewalk, etc. See Section 3.12.6 on page 3.36 for requirements when backfilling a trench which crosses or is beneath pavement.

3.2.2. Missouri Department of Transportation Approval. The treatment of the intersection of any new street with a State highway shall be subject to approval by the District Engineer of the Missouri Department of Transportation (MoDOT).

3.2.3. Subdivisions Adjacent to Existing City Streets. At such times as a subdivision is proposed adjacent to a street that is accepted and maintained by the City, that street and other streets required shall be improved to handle the increased traffic due to said subdivision as directed by the Department of Public Works and the additional right-of-way and the cost of improvement of the right-of-way adjacent to the proposed subdivision shall be included in the overall subdivision improvements. The improvements shall be made to current City specifications and standards.

3.2.4. Future Access. In certain cases involving the subdivision of tracts of property, the reservation of right-of-way access may be required for future road improvements as authorized by the tract's preliminary plat. The reservation of right-of-way access shall be considered for the following roadways: including but not limited to Congress Street (Hwy. N), Denton Road, First Street (Hwy. OO & Hwy. F), Gray Summit Road, Industrial Drive, Osage Street, Payne Street, and Thornton Road.

3.2.5. Street Design. All street construction, modification or widening shall be designed in accordance with the requirements of the Design Details and Specifications contained in these Standards. Block length and street jogs shall be addressed as discussed in Sections 3.1.4.2 and 3.3.2, respectively. All construction of roadway improvements within the City shall be accomplished under the observation and inspection of the Department and shall be subject to its approval.

3.2.6. Street Name Signing

3.2.6.1 Reflectorized street signs bearing the name of the street and the block number, as designated on the record plat, shall be placed at all street intersections and at the beginning and endpoints of continuous streets which change direction and name. Each and every intersection formed shall have at least one street name sign for each intersecting street mounted in a bracket on top of one post. Two sets of street name signs on separate posts shall be required at intersections where one street is a collector street or an arterial roadway. Refer to Design Details STR.16 and STR.18.

3. STREETS & PARKING

3.2.6.2 Street names shall comply with all provisions found in Section 525.480 of the Pacific City Code.

3.2.6.2.1 All streets dedicated to the City of Pacific or remaining in private ownership within the City of Pacific and all streets or thoroughfares henceforth to be created shall not be named the same name as any street currently in existence in the Counties of Franklin, Jefferson or St. Louis, State of Missouri.

3.2.6.2.2 No street or thoroughfare name which is adopted or used shall be used subsequently with a different suffix, i.e., Street, Avenue, Court, Place or Drive.

3.2.6.2.3 Where an extension to a street or new street continues in the same direction as an existing street or thoroughfare whether connected or not connected to the existing street or thoroughfare the new street shall be named the same as the previous existing street or thoroughfare. (Ord. No. 1891 §§ 1-3, 2-6-96.)

3.2.6.3 No street shall have a name which will duplicate, or so nearly duplicate as to be confused with, the name of an existing street, unless the proposed street is an extension of, or in alignment with, an existing street, in which case the duplication shall be mandatory.

3.2.6.4 Street names shall be submitted to the City Clerk/Administrator for approval prior to the submission of the preliminary plat.

3.2.6.5 Each sign post shall be placed no less than 1.5 feet from the sidewalk and not less than 3.5 feet from the back of curb, in the tree lawn. Signs indicating both streets should be erected at each location. Street name sign posts shall be located where they may be used for future "Stop" or "Yield" signs. This means that one set of street name signs shall be installed on the near right corner for the lesser volume roadway. Also, when one of the intersection streets is a collector street or an arterial roadway, two sets of street name signs shall be required. Refer to Design Details STR.16 and STR.18.

3.2.6.6 The Department shall approve the location and inspect the installation of street name signs in all subdivisions. The size, height, and type of sign shall be in accordance with these specifications.

3.2.7. Guard Rail

3.2.7.1 Guard rail shall be required to protect traffic from hazardous features, or to restrict or prohibit traffic movements. Guard rail will be required for roadway fill heights of 10 feet or more adjacent to the roadway or fill heights of 7 feet or more at pavement terminations. Terminal sections will be required for both directions of traffic flow on two-way pavement. Where the distance between terminal sections of two sections of guard rail will be 100 feet or less, one continuous length of guard rail shall be installed.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Guard rail shall be provided for protection of traffic adjacent to creeks and lakes, at bridge ends, piers, and headwalls, and as directed by the Department.

3.2.7.2 Roadway Berms. The grading and placement of berms within the street right-of-way as an alternate to guard rail may be permitted with special approval by the Department where such installations are considered compatible with the roadway typical section. Berms shall be constructed to a height of 3 feet above the adjacent edge of pavement or curb with 3:1 side slopes.

3.2.8. Medians. Raised median strips may be required by the Department to restrict through and/or left turning movements at or near driveways, commercial entrances and/or street intersections. Raised medians may also be utilized for ornamental entrance monuments and signs. For ultimate tee type street intersections, where the median is proposed on the minor side street, wider medians may be permitted by the Department to accommodate larger entrance monument designs.

3.3. STREET STANDARDS

3.3.1. Street Arrangement

3.3.1.1 The arrangement, character, extent, width, grade and location of all streets and required improvements shall be considered in their relation to existing and proposed streets, to topographical conditions, to public convenience and safety, and in their appropriate relation to the proposed uses of the land to be served by such streets.

3.3.1.2 Arrangement of subdivision streets shall make provision for the extension and/or relocation of arterial, collector and minor streets, which impact the property. Except for cul-de-sacs, streets normally shall connect with streets already established, or provide for future connections to adjoining unsubdivided tracts, or shall be a reasonable projection of streets in the nearest subdivision tracts.

3.3.1.3 Reserved strips of land which control or limit access at the terminus of streets or prevent access to streets located adjacent to undeveloped land are prohibited.

3.3.2. Street Intersections

3.3.2.1 Minor street intersection jogs or discontinuities with centerline offsets of less than one hundred (125) feet shall be avoided.

3.3.2.2 Streets shall be laid out to intersect as nearly as possible at right angles. A subdivision entrance street shall intersect the major or collector street with an interior angle of seventy-five (75) to ninety (90) degrees unless otherwise approved by the Department. Each entrance street shall be positioned to provide required sight distance along each intersecting roadway as determined by the Department. Refer to Design Detail

3. STREETS & PARKING

STR.19 for Sight Distance at Intersections criteria. Intersection of more than two (2) streets at one point is prohibited.

3.3.2.3 A minimum radius of twenty (20) feet (or the chords of such arcs) at the street right-of-way intersection and a minimum radius of thirty-two (32) feet at the back of the curb shall be required. If the angle of intersection of two (2) streets is less than sixty (60) degrees, the radius of the arc at the intersection of the property lines and at the back of the curb shall be approved by the Commissioner. Greater radii and channelization may be required at an intersection with a major or collector street or to provide access for vehicles having large turning radius requirements.

3.3.2.4. At intersections of streets with alleys, the property line corners shall be rounded with a radii of not less than fifteen (15) feet or chords of such arcs.

3.3.2.5 All interior residential streets intersecting on collector streets shall be directly opposite existing or other proposed streets or shall be a minimum of three hundred (300) feet distant, as measured between street center lines. Additionally, all other streets intersecting on arterial streets shall be directly opposite existing or other proposed streets or shall be a minimum of three hundred (300) feet distant, as measured between street center lines.

3.3.2.6 Where a collector street enters or connects with an arterial street, the Department must approve the entrance plan.

3.3.3. Street Grades at Intersections

3.3.3.1 The grade of collector and minor streets shall not be greater than four percent (4%) for a distance of fifty (50) feet from the center of any intersection. See Design Detail STR.20.

3.3.3.2 The grade of arterial streets shall not be greater than three percent (3%) for a distance of fifty (50) feet from the center of any intersection. See STR.20.

3.3.4. Stub Streets

3.3.4.1 Stub streets shall be constructed to the property lines when required to provide for future connections to adjoining undeveloped tracts. Reasonable projections of streets in nearby subdivisions will establish the location of certain stub streets. In no case shall stub streets exceed 400 feet in length.

3.3.4.2 A temporary turnaround or backaround with a minimum pavement width of 26 feet may be required on all stub streets. Permits will not be issued for building construction on lots abutting a temporary turnaround as shown on any recorded subdivision plat unless and until the temporary facility is actually constructed and has been approved by the Department.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.3.4.3 Prior to expiration of the land subdivision bond or escrow agreement required of the development under Section 405.050(D) or Section 410.050(D) of the Zoning and Subdivision Code, the removal of temporary turnaround surfacing shall be provided for by an Agreement Guaranteeing Road Improvement (Special Escrow), together with a cash sum or Irrevocable Letter of Credit.

3.4. DESIGN DETAILS

3.4.1. General. All streets and parking areas shall be designed to meet or exceed the full minimum requirements set forth in the Supplemental Regulations, Sections 400.200 and 400.235 of the Zoning and Subdivision Code. These Regulations and the Standards contained herein are designed to provide the maximum allowable flexibility in street construction, while at the same time, insuring the protection of the public interest. The widths of right-of-way and pavement are allowed to vary as functions of the type of street and the corresponding intensity of use.

3.4.2. Subdivisions Along Existing Streets

3.4.2.1 Subdivisions that adjoin or include existing streets or roads that do not conform to the required right-of-way widths shall dedicate additional width along either or both sides of such streets or roads. When a subdivision is located on one side of an existing City street or road, a minimum of one-half (1/2) of the required right-of-way shall be provided, measured from the center line of the right-of-way as originally established. Additional right-of-way in excess of twenty (20) feet may be required when the subdivision is located on the inside of a curved roadway or conditions exist on the opposite side of the right-of-way which dictate right-of-way offset from the right-of-way centerline. The centerline must meet the requirements of the Department with regard to radius when located on a curved roadway.

3.4.2.2 For any development fronting on an existing City street, it shall be the responsibility of the developer to bring the street up to City specifications to the center line of the street. Curb and gutter and sidewalks are to be installed by the developer on the developer's side of the street only.

3.4.3. Subdivisions Along Railroads

3.4.3.1 A subdivision plat involving new or existing streets crossing railroad tracks shall provide adequate rights-of-way, including approach rights-of-way and slope easements for construction of an underpass or overpass, unless otherwise specified by the Department. Approval from the railroad of record and any other governing body (Missouri Department of Transportation, County Highway Department, etc. if applicable) must be received relative to all railroad crossings. The developer may be required to install crossing signals.

3. STREETS & PARKING

3.4.3.2 A street on which residential lots front and which parallels, but is not adjacent to a railroad right-of-way, shall be at a distance from the railroad right-of-way sufficient to provide lots with a minimum depth of one hundred sixty (160) feet. The rear building line (parallel to the railroad right-of-way) shall be a minimum of 75 feet.

3.4.4. Curbing Required. Commercial, industrial and residential subdivision streets shall be constructed with vertical curbs on both sides unless approved for roll curbs by the Commissioner.

3.4.5. Dedication of Streets.

3.4.5.1 All streets shall be dedicated to public use unless approved for private use by both the Commission and the Department.

3.4.5.2 If roadways are designated to be private roadways, these roadways shall remain private. Maintenance of private roadway will be the responsibility of the property owner(s) or trustees forever.

3.4.6. Extraordinary Conditions. Additional lanes and/or widening, pavement thickness, drainage facilities, granular base and/or traffic control devices may be required at the direction of the Department to accommodate heavy traffic volumes, unsuitable soil conditions, steep grades or other conditions encountered in the design of streets.

3.4.7. Parking During Construction. The developer shall provide adequate temporary off-street parking for construction employees. Parking on non-surfaced areas shall be prohibited in order to eliminate the condition whereby mud from construction and employees vehicles is tracked onto the pavement causing hazardous road and driving conditions.

3.4.8. Flood Protection. If any public roads are proposed within a development, they must be built above the 100-year flood elevation or protected from flood damage by an approved levee. Any construction in the flood plain must meet the requirements of the Corps of Engineers and MDNR and obtain permits as required. Any roads and/or drives proposed below this elevation, not protected by an approved levee, are to be private and remain private forever.

3.4.9. Tangents on Reverse Curves. A tangent of less than one hundred (100) feet in length shall be avoided between reverse curves on arterial streets and forty (40) feet in length on collector and minor streets.

3.4.10. Vertical Curves. All changes in grade shall be connected by vertical curves to provide a smooth transition and the required sight distance. Design criteria for vertical curves is contained in to Design Details STR.40.

3.4.11. Pavement Lugs for Rigid Pavement

3.4.11.1 Pavement lugs will be required on all street grades of seven percent (7%) or greater and must be approved by the Department. Spacing of pavement lugs will be as follows:

- a) 200 foot intervals on tangent sections.
- b) 100 foot intervals on horizontal curve sections.

3.4.11.2 Pavement lugs shall be located at or near the point at which the street grade first reaches seven percent (7%) and proceed uphill at the required spacing with the last pavement lug located at or near the point at which the street grade becomes less than seven percent (7%).

3.4.11.3 Pavement lugs shall be constructed:

- a.) 4 feet in depth for street grades between 7% and 12%.
- b.) 5 feet in depth for street grades above 12%.

3.4.11.4 Type A2 Expansion Joints are required with each pavement lug and shall be located 10 feet downgrade of each pavement lug installation (see Design Detail STR.70 for joint details).

3.4.11.5 For construction details of the pavement lug and joints, refer to Design Details STR.70 and STR.75.

3.4.12. Sight Distance. Sight distance criteria shall be based upon the ultimate number of lanes required for the roadway. Refer to Design Details STR.19 for Sight Distance at Intersections criteria. If required sight distance cannot be provided at the access location, acquisition of right-of-way, removal of plant material, reconstruction of pavement, sight distance easements and other off-site improvements may be required to provide the required sight distance as directed by the Department.

3.4.13. Additional Right-of-Way Obtained by City. When portions of roadway improvements required for the safety of the public require the acquisition of additional right-of-way and easements from private property, the normal sequence of design, right-of-way acquisition and construction shall commence immediately upon approval of the requested rezoning. If the developer is unable to acquire the necessary right-of-way and easements through negotiation with the particular property owners involved, the City will acquire same through eminent domain proceedings. The cost of appraisals, negotiations, administration, court proceedings and all associated costs incurred by City proceedings shall be paid by the developer.

3. STREETS & PARKING

3.4.14. Entrance Landscaping and Monuments. Installation of landscaping and ornamental entrance monument construction, shall be reviewed by the Department for sight distance considerations and approved prior to installation or construction. Refer to Landscaping, Section 3.9. Any/all monuments shall comply with Pacific City Code, Chapter 425: Sign Code.

3.4.15. Existing Deficient Pavement in City Streets. Proposed developments utilizing roadways with structurally deficient pavement within the site, or providing access to the development from such roadways, may be required to overlay the existing road surfacing or make other remedial improvements, as required by the Department, to bring the structural stability of the pavement up to minimum requirements.

3.4.16. Longitudinal Joints and Striping. All longitudinal joints in concrete pavement shall be constructed along proposed lane lines as directed by the Department and as shown on Design Details STR.25 and STR.70. Where proposed lane striping and existing longitudinal joints do not coincide, a two (2) inch overlay of Type "C" Asphaltic Concrete Wearing Surface shall be required.

3.4.17. All joints shall be sealed with an asphalt-rubber compound. Application of the sealant shall be done in accordance with manufacturer's specifications. One approved product is "Asphalt Rubber Plus" Sealant, as manufactured by CRAFCO, Inc., Chandler, AZ, or equivalent, as approved by the Commissioner.

3.4.18. Collection of stormwater runoff shall be achieved via curb inlets or via a method approved by the Commissioner. In no case shall the use of trench grates or grated troughs be permitted within the City unless approval is granted by the Commissioner. Underdrains, where required, shall conform to Design Detail STR.80.

3.5. ENTRANCE STANDARDS

3.5.1. General. Regardless of zoning classification, all entrances shall be constructed with concrete aprons. Entrances shall transition from the flow line of the gutter to the elevation of the top of curb at the right-of-way line. All entrance construction within City street and roadway right-of-way shall be constructed in accordance with these Specifications and the Entrance Standards, shown on Design Details STR.21 through STR.24. Refer to Design Details STR.19 for Sight Distance at Intersections criteria. Any entrances from state or county roads shall comply with the appropriate specifications of the governing body(s).

3.5.2. Residential Entrances

3.5.2.1 Residential entrances on existing City streets shall not be less than twelve (12) feet wide nor more than twenty-four (24) feet wide at the right-of-way line.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.5.2.2 Residential entrances on existing City streets shall be located so the edges of the curb opening shall be a minimum of five (5) feet from the nearest edge of street inlets and twenty (20) feet from the street corner radius point. The edges of the curb opening shall not project beyond the side property line extended normal to the pavement.

3.5.2.3 In the case of corner lots, no driveways shall be constructed within the sight triangle area bounded by the property lines of a corner lot and a line connecting two (2) points on the property lines each measured thirty (30) feet from the intersection of the two property lines at the intersection. Where applicable, easement lines shall be substituted for property lines (See Design Detail STR.22).

3.5.2.4 The distance between adjacent residential entrances shall be a minimum of twenty (20) feet measured along the road right-of-way line. When residential development conditions necessitate reduction of the distance between adjacent residential entrances to ten (10) feet or less, the Department may require a Common Entrance Approach.

3.5.3. Commercial Entrances

3.5.3.1 Commercial entrances shall not be less than twenty-four (24) feet wide or more than forty (35) feet wide at the right-of-way line. The radius used to increase the opening at the curb or pavement edge shall not be less than ten (10) feet. Exception to the width and/or radius may be required, or allowed with special approval by the Department, to insure adequate provisions for large vehicles and/or high traffic volumes.

3.5.3.2 Commercial entrances shall be located in accordance with the site plan requirements and shall be designed so the edges of the curb opening shall be a minimum of five (5) feet from the nearest edge of street inlets and as far as possible from the street corner radius point. The edges of the curb opening shall not project beyond the side property line extended normal to the pavement.

3.5.3.3 In the case of corner lots, no entrances, parking spaces or other obstacles shall be constructed or placed within the sight triangle area bounded by the property lines of a corner lot and a line connecting two (2) points on the property lines each measured thirty (30) feet from the intersection of the two property lines at the intersection. (See Design Detail STR.24).

3.5.3.4 The number of commercial entrances for each parcel or site shall be limited on the basis of traffic requirements as determined by the Department. The maximum number of commercial entrances allowed, if all traffic requirements are satisfied, shall be as indicated in Table 3-6.

3.5.3.5 Properties which have frontage on two or more streets shall have the number of commercial entrances on each street limited in accordance with traffic requirements and the above guideline. The distance between adjacent commercial entrances

3. STREETS & PARKING

shall be minimum of one hundred (100) feet measured along the road right-of-way line, unless otherwise approved by the Department.

3.5.3.6 For a service and/or gas station or a convenience store with gas sales development on a corner lot, the following guidelines are established. For a new development on a lot for which previous use was not associated with service and/or gas station or a convenience store with gas sales: One (1) entrance intersection from each street shall be permitted and located as far as possible from the street intersection corner. For redevelopment (complete rebuilding) of a lot for which present use is associated with service and/or gas station or a convenience store with gas sales which is presently served by less than three (3) entrances: One (1) entrance intersection from each street shall be permitted at a location approved by the Department.

Table 3-6
Maximum Number of Commercial Entrances Allowed on Each Parcel or Site

Frontage (feet)	Max. No. Commercial Entrances	Left Turn Restrictions (When required by the Department)	
		Method of Restriction	Standard Drawing Number
Less than 200	One (1)	Median	STR.76
200 to 500	Two (2)	Median or Rt. In - Rt. Out Channelized Entrance	STR.76 or STR.77
500 to 1,000	Three (3)	Rt. In - Rt. Out Channelized Entrance	STR.77
More than 1,000	As directed by Dept.	Rt. In - Rt. Out Channelized Entrance	STR.77

3.5.3.7 For redevelopment of a present use which is presently served by three (3) or more entrances: The two (2) entrances located farthest from the corner may remain. The entrance located nearest to the corner on the inbound approach of the intersection shall be removed and the right-of-way restored to surrounding conditions or improved as required. The entrance located nearest to the corner on the outbound approach of the intersection may remain provided that this entrance is restricted, where required by the Department, to right turns in and right turns out by an existing or required median. For remodeling or renovation of an existing use (i.e. canopy addition, island replacement or addition, dispenser replacement or addition, sales area renovation or addition, car wash

PACIFIC DESIGN & CONSTRUCTION STANDARDS

addition) all existing entrances shall be permitted to remain except when changes to circulation patterns to the driveways result in an increased emphasis on the entrance located nearest the inbound approach of the intersection. Such entrance shall then be subjected to further review and possible elimination by the Department.

3.5.4. Left Turn Restrictions. The restriction of entrance turning movements will require the construction of right in - right out channelized entrances or raised median, as directed by the Department, based upon proximity to the nearest intersecting street or driveway, left turn storage requirements within the public right-of-way, development land use and traffic generation, sight distance limitations and cross access provisions as indicated in the above guidelines.

3.5.5. Entrance Clearance. Residential and commercial driveway entrance locations which do not meet the side property line clearance requirements (Design Details STR.22 through STR.24) shall not be approved for construction without a consent letter from the abutting property owner.

3.5.6. Temporary Emergency Access. In certain instances, the Department may grant temporary access to roadways for emergency vehicles only. The access shall be a 12-foot wide, 12-inch thick rock drive with a standard paved approach within the right-of-way constructed of Type "X" Asphaltic Concrete Base - 6" thick and Type "C" Asphaltic Concrete Wearing Surface - 2" thick. A gate must be provided across the drive at the right-of-way line with the sign, "Emergency Vehicles Only" on each side of the gate. The gate shall have a lock with the only keys thereto in possession of the Department of Public Works, the Pacific Police Department and the Fire Protection District.

3.5.7. Cross Access

3.5.7.1 Cross access is defined as a commonly shared or used pedestrian way or vehicular driveway that connects or serves two or more properties. The purpose of cross access may be to reduce the number of entrance intersections to an arterial or collector street, to provide access via a signalized intersection, to provide direct access between adjacent developments, to provide access to lots not having street frontage, etc.

3.5.7.2 Cross access may be required as part of the Site Plan or Subdivision Review Procedure, zoning request, and/or special procedure request and shall be provided in accordance with the following conditions:

- a) At the time the site plan is submitted for review, the Department will identify adjacent existing land use and its potential for change, existing traffic volumes and design features of the surrounding roadways, etc. in order to ascertain requirements for cross access. If cross access is required, the plan shall show the area to be included for cross access to include the driveway approach, internal driving and parking lot aisles and their extension to the property line(s) at the area(s) designated for connection to adjacent property.

3. STREETS & PARKING

In the event that cross access has not previously been established on adjacent property, no pavement connection to adjacent property is required other than that necessary for the functioning of the site.

b) The area designated for cross access shall be kept free of all landscaping, fences, trash enclosures, parking/loading spaces, and/or other improvements except as required by The Zoning and Subdivision Code. Any approved improvements located in the areas designated for cross access shall be removed by the developer who is required to construct the pavement connection.

c) A Temporary Slope Construction Permit shall be provided to facilitate construction of the future cross access by the adjacent development or property owner. Maintenance of cross access areas shall be accomplished by each property owner or as may be agreed to by the owners. The owners shall provide copies of all such agreements to the Department for approval prior to execution and recording.

d) The Cross Access Easement Agreement shown on Exhibit No. 1 (pages 3.36 through 3.38) may be duplicated or modeled as necessary for execution and submitted to the Department as part of the improvement plan approval.

e) Any modification of the Cross Access Easement Agreement shall be reviewed by the City Attorney and the Commissioner of Public Works and approved prior to execution and recording.

3.6. SIDEWALKS AND HANDICAP RAMPS

3.6.1. Sidewalks shall be built in front of all developed parcels except when waived pursuant to paragraph 3.6.8. When a parcel is developed on a corner lot or double frontage lot, a sidewalk shall be built on both streets (See Design Detail STR.16).

3.6.2. Construction of sidewalks require an excavation permit issued by the City of Pacific. Construction of sidewalks in new subdivisions is covered by the permit for the street inspections.

3.6.3. Sidewalks shall be placed at the right-of-way line to provide for a tree lawn and have a minimum thickness of four (4) inches, full depth. Sidewalks crossing driveways and driveway aprons shall have the following thicknesses:

3.6.3.1 Residential - four (4) inches, full depth

3.6.3.2 Commercial and industrial - seven (7) inches, full depth

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.6.4. The minimum width of sidewalks shall be four (4) feet with a tool groove every five (5) feet and an expansion joint every twenty-five (25) feet. Joints shall continue through all driveways (See STR.17). Sidewalk cross slope shall be one-fourth (1/4) inch per foot, falling to the street. Sidewalks shall have a brush finish without swirls or borders.

3.6.5 The expansion joint shall be wolmanized lumber anchored into the sidewalk (See STR.17 for details). Any other type of joint shall be approved by the Commissioner prior to construction. Felt used as an expansion joint is prohibited, unless approved by the Commissioner.

3.6.6. Sidewalks shall be constructed with 4,000 p.s.i. concrete. A two (2) inch thick stone base of Type 3 aggregate shall be installed on firm or compacted soil. Sidewalk pavement shall consist of Portland cement concrete consisting of six and one-quarter (6 1/4) sacks of cement per cubic yard, with a maximum slump of four (4) inches. All concrete shall be air-entrained with an air content of 4 to 6 per cent. No calcium chloride shall be added to the mix.

3.6.7. Sidewalks at all intersections shall be handicapped accessible. Curb cuts and appropriate slopes are required for both rolled and vertical curbs. Curb cuts at mid-block or at any location other than at corners shall not be permitted unless approved by the Department.

3.6.8. The installation of sidewalks in subdivisions developed exclusively for industrial uses may be waived at the discretion of the Commission and the Board of Aldermen.

3.7. CURBS AND GUTTERS

3.7.1. All streets shall be constructed with Portland cement concrete curbs and gutters on both sides of the street. Curbs and gutters shall be thirty (30) inches wide with a six (6) inch high vertical curb. A four (4) inch high rolled curb may be used in subdivisions which will be exclusively single family residences, as approved by the Commissioner. All curbs and gutters shall be constructed of 4,000 p.s.i. concrete, regardless of shape. Gutters shall be six (6) inches in thickness with an expansion joint every ten (10) feet.

3.7.2. When installing driveway approaches where curbs and gutters already exist, the entire curb and gutter must be removed and replaced. In no case can the back of the curb be removed and the driveway joined at the gutter flow line.

3.7.3. Where existing curbs on adjacent properties are roll type, curbs shall be transitioned to vertical type.

3. STREETS & PARKING

3.8. STREET LIGHTING

3.8.1. Provisions shall be made by the developer for installation of street lights along all public streets within any subdivision. Street lights shall be placed in accordance with the following:

3.8.1.1 At each intersection of street.

3.8.1.2 At each circular turn-around.

3.8.1.3 At intervals of not greater than three hundred fifty (350) feet between such locations.

3.8.1.4 Light poles shall be located within the tree lawn, 2.5 feet off the back of curb. A greater setback may be warranted and thereby granted by the Commissioner in industrial or commercial areas.

3.8.2. Street lights shall be mounted on poles and shall be serviced by underground wiring only.

3.8.3. Electric current for street lighting on public streets will be provided by the City of Pacific without additional cost to property owners.

3.9. LANDSCAPING IN THE RIGHT-OF-WAY

3.9.1. General. All landscaping within City street right-of-way shall be planted and installed in accordance with these Standards and the Pacific City Code. Only trees or other approved materials shall be planted in the tree lawn. Planting of hedges, shrubs, ornamental entrances and monuments, berm slopes, raised flower beds, etc. within the right-of-way is not permitted.

3.9.2. Location. In addition to the minimum requirements listed in the Zoning Code, medium to large deciduous shade trees shall be planted along the public right-of-way at a distance of forty-five (45) feet apart. Trees shall not be located within any site distance triangle. The Commissioner shall determine exact location for placement of trees.

3.9.3. Ornamental Entrance Monuments and Signs. Structures and/or signs proposed at subdivision and commercial development entrances shall conform to the requirements of the Sign Code. The width, height, and location of all entrance monuments and signs shall be reviewed with relation to the existing and proposed streets and/or major commercial driveway intersections for possible sight distance restrictions affecting nearby vehicular and pedestrian traffic and other requirements as follows:

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.9.3.1 Ornamental entrance monuments and signs when located in medians approaching street intersections shall be located a minimum of twenty (20) feet from the prolongation of the intersecting road right-of-way or easement line and constructed symmetrically about the median centerline.

3.9.3.2 Monuments and signs located in proximity to the street intersection corners shall not be located within the road right-of-way.

3.9.3.3 Monuments and signs located within the Sight Distance Triangle area of the street intersection corners shall be subject to the height limitations governing trees and plant materials described in paragraph 3.9.2 above.

3.9.3.4 Ornamental entrance monuments and signs shall not be placed or constructed within the public road right-of-way or easement without authorization by the Department through the issuance of a permit.

3.9.3.5 Plans shall be provided showing elevation and section views of the proposed construction. Plans shall indicate the location of the adjacent right-of-way, easements, curbing, sidewalk, street pavement, utilities and/or landscaping.

3.9.3.6 Plans for monuments and sign structures shall be approved by the Department prior to issuance of the permit. Where special permits, i.e., building, electrical and/or plumbing are required, they shall accompany the plans.

3.9.3.7 Sight distance triangles shall be shown on the plans.

3.9.3.8 Indentures must provide for maintenance and repair of structures and signs authorized by permit.

3.9.3.9 Indentures must hold the City harmless from all claims, demands and suits of any kind arising out of, or in conjunction with, any permits issued.

3.9.3.10 Entrance monuments and signs located within the public road right-of-way under permit authorization shall be removed if requested in writing by the Department.

3.9.4. Tree Lawn - Allowable Materials

3.9.4.1 The minimum width of the tree lawn shall comply with STR.01 through STR.12. Grass, pavement blocks (permeable), asphalt and trees are allowed in the tree lawn. Compliance with Sections 400.230 and 525.010 of the Pacific City Code is required.

3.9.4.2 Tree species to be used in tree lawns along road sides are the Honeylocust (*Gleditsia Triacanthos* var. *inermis*), Littleleaf Linden (*Tilia Cordata*), Zelkova

3. STREETS & PARKING

(Zelkova Serrata), Sweet Gum (Liquidamber Stryaciflua), Northern Red Oak (Quercus rubra), Scarlet Oak (Quercus coccinea), Shingle Oak (Quercus imbricaria), and True Pin Oak (Quercus Palustris) and are planted at an interval of forty-five (45) feet. The above tree species are recommended due to their deeper growing root systems and thus reduce damage to nearby curbs and sidewalks.

3.9.5. Hazardous Situations. The following guidelines have been established to properly identify possible plant material and barrier hazards (See Pacific City Code 525.020):

3.9.5.1 A fence, of any kind, is prohibited in any City right-of-way.

3.9.5.2 Rocks, railroad ties, or other posts located within the City right-of-way may not necessarily be a hazard. These barriers could be hazards if they are located in the path of normal pedestrian traffic and/or are located so close to the edge of pavement that motorists could strike them.

3.9.5.3 Plant material located on the corners of intersections could be a hazard if motorists are unable to see cross traffic approaching.

3.9.5.4 Trees with low branches across a sidewalk or walkway could be a hazard to pedestrians.

3.9.6. Inspection and Removal. Within City right-of-way, certain cases may dictate the need to remove any plant material including trees. The discretion and authority to remove such plant material is the function of the Department of Public Works. In order to ensure that plant material and barrier hazards have been removed from City streets where necessary, the following policy shall be effective:

3.9.6.1 The Department shall investigate all possible hazards created by plant material and barriers that are known through citizen complaints and/or by report from Departmental personnel, the Police Department or the Fire District.

3.9.6.2 When it is determined that certain plant material and/or barriers installed by the abutting property owner are hazardous (that is, obstruct or endanger traffic) or constitute a nuisance, the Department shall notify the property owner of the hazard or nuisance and request removal of same as soon as possible.

3.9.6.3 After a reasonable length of time, the Department will conduct a follow-up investigation to determine if the property owner has corrected or removed the hazard or nuisance.

3.9.6.4 If the notified property owner has not corrected the hazard or nuisance, the Department will make arrangements to remove said hazard or nuisance as soon as possible without further notification to the property owner.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.9.7. Other Landscaping Concerns.

3.9.7.1 Ground Cover. The Department may require sodding or other means of ground cover to insure erosion control.

3.9.7.2 Common Land. The Department may require the clearing of underbrush, sodding, seeding, and other landscaping improvements in that portion of the common land that has been altered or graded.

3.10. OFF-STREET PARKING AND LOADING

3.10.1. Parking

3.10.1.1 General

3.10.1.1.1 For all buildings or structures hereafter constructed, reconstructed, or expanded, off-street parking shall be provided. Such parking areas shall be located entirely on private property, except the necessary drives may cross the right-of-way to connect the roadway with the parking area.

3.10.1.1.2 The issuance of a building permit or commercial use permit shall require compliance with the parking area requirements as herein provided. Hard surfacing of parking areas shall be required upon the issuance of a building permit even though additional spaces are not required to be constructed.

3.10.1.2 Off-Street Parking Requirements

3.10.1.2.1 Off-street parking shall be provided in the amounts specified in Table 3-7. In the case of a use which is not specifically mentioned, off-street parking requirements for a similar use shall apply. Similarity shall be determined by the Zoning Officer. These requirements shall apply to each type of use regardless of the zoning district.

3.10.1.2.2 The method of computation shall be as follows:

a.) Gross floor area (gfa) shall be determined by using the outside dimensions of the building for each floor. The only space which may be excluded is basement storage area.

b.) Employees shall include all persons working or serving at a place of business, including the owner, manager, doctors, nurses, technicians, teachers, kitchen workers, and all other employees.

3. STREETS & PARKING

**Table 3-7
Off-Street Parking Requirements**

Use	No. Parking Spaces	Required for Each
Residential		
Single-Family Dwellings	2	Dwelling Unit
Two-Family Dwellings	2	Dwelling Unit
Multi-Family Dwellings		
Efficiency Studio	1	Dwelling Unit
1-2 Bedroom	1.5	Dwelling Unit
3 or more bedroom	2	Dwelling Unit
Hotels & Motels	1 plus number required for restaurant or banquet & assembly rooms, if any	Room
Fraternity & Sorority Houses	0.5	Member
Dormitories	0.5	Resident
Commercial		
Banks	5	1,000 sf of gfa
Offices	5.5	1,000 sf of gfa
Offices - Medical & Dental	1	Employee, Plus
	4	Doctor
Restaurant	1	3 Seats
Bowling Alley	5 Plus number required for restaurant, if any	Lane
Personnel Services	5	1,000 sf of gfa
Retail Stores	5	1,000 sf of gfa
Service Stations, Gas Stations, Auto Repair Shop or Garage	5	1,000 sf of gfa with a min. req'd 4 spaces regardless of size of building
Industrial - Including Storage, Wholesale and Manufacturing		
Brick or lumber yard or similar yard	1	Employee, Plus # req'd for Retail & Office Space
Open storage of sand, gravel & petroleum	1	Employee, plus # req'd for Retail & Office space
Warehouse & enclosed storage - private	1	Employee
Warehouse & enclosed commercial	1	Employee, plus 3,000 sf of gfa
Manufacturing operations - single-shift	1	Employee, plus req'd number for Retail &/or Office space
Manufacturing operations - multi-shift	1	Employee on largest shift & second shift, plus req'd number for Retail &/or Office space

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Institutional and Other		
Hospitals	1	2 beds, plus
	1	Employee
Nursing Homes	1	4 beds, plus
	1	Employee
Auditoriums, churches, theaters, stadiums, and other places of assembly	1	4 seats
Colleges	1	2 students, plus dorm requirement
High Schools	1	Employee, plus
	1	4 Students
Elementary & Middle Schools	1	Employee, plus
	1	Classroom
Day Care Facilities	1	8 Children, plus
	1	Employee
*Note: Abbreviations are as follows: sf - square feet, gfa - gross floor area		

c.) The number of employees shall be based upon the total number of employees on duty at any one time, when the maximum functional use of the building or land is being made.

d.) A multi-shift operation shall include businesses which have more than one group of employees who are on duty for different periods of time.

e.) Where more than one type of use is located either in the same building or in separate buildings in close proximity, such that a single parking area will be serving those uses, the number of parking spaces provided shall be not less than the sum of the separate requirements for each use.

f.) When determination of the number of off-street parking spaces required by the formulas result in the requirement of a fractional space, any fraction of one-half or less may be disregarded, while a fraction in excess of one-half shall be counted as one parking space.

g.) Members of a fraternity or sorority shall include pledges, actives, and employees, whether living on the premises or not.

3.10.1.2.3 Joint Use of Parking Facilities. Where more than one type of use is located either in the same building, or in separate buildings in close proximity, joint use of the same parking facilities will be allowed as follows:

a.) Uses normally open or operated during daytime hours, including retail stores, personal service establishments (such as beauty shops and barber shops), and business service establishments (such as banks and offices) may share parking facilities with the following uses:

3. STREETS & PARKING

b.) Churches which have activities only on week-ends or evenings may share such parking facilities to the extent of 100% of the parking spaces required.

c.) Uses normally open or operated during evening or weekend hours, such as theaters, bowling alleys, dance halls, other places of amusement, and restaurants, may share such parking facilities to the extent of 50% of the parking spaces required.

d.) A written agreement for any joint use of off-street parking facilities shall be properly drawn and executed by the parties concerned, approved as to form by the City Attorney, and filed with the application for a building permit.

3.10.1.3 Dimensions of Parking Area.

3.10.1.3.1 Size of stalls. A required off-street parking space shall be a rectangle which is a minimum of 9 feet wide by 19 feet deep, placed at the prescribed angle so that it lies between the curb and the aisle.

3.10.1.3.2 Aisle width. Aisles shall provide access to parking spaces and shall provide the necessary space for maneuvering into and out of each space. They may serve either double or single bays of parking. The width of aisles providing access and maneuvering space shall be as shown in Table 3-8.

3.10.1.3.3 In the event that the desired parking angle is not specified by the Parking Table, the Department may specify other equivalent dimensions associated with the desired parking angle by interpolating the dimensions listed in Table 3-8.

Table 3-8
Required Parking Dimensions

Parking Angle, degrees	Stalls Serviced by Aisle	Traffic Flow	Aisle Width, feet
90	One Side	One or Two Way	24
90	Both Sides	Two Way	24
45	One Side	One Way	16
60	One Side	One Way	16
45	Both Sides	One Way	16
60	Both Sides	One Way	20
45	Both Sides	Two Way	20
60	Both Sides	Two Way	20

3.10.1.4 Ingress and egress.

3.10.1.4.1 Off-street parking areas in all zoning districts shall provide ingress and egress to any public right-of-way only at such location as approved by the Department. Ingress and egress shall be by means of paved driveways not exceeding thirty-five (35) feet in width at points of connection with public streets. The minimum width of driveways for ingress and egress shall be the same as those specified above for aisles.

3.10.1.4.2 The minimum distance of a parking area entrance drive from the intersection of two streets shall be based on the dimensions contained in Table 3-9. All measurements shall be taken from the right-of-way lines. Exceptions to these minimum distances may be allowed in the C-1 Zoning District when necessary due to existing conditions resulting from the original street design of the town.

**Table 3-9
Minimum Distance - Parking Lot Entrance to Street Intersection**

	Arterial	Collector	Minor
Intersection ROW to Curb Cut	50 ft.	25 ft.	25 ft.

3.10.1.5 Improvement of Parking Area.

3.10.1.5.1 In all zoning districts, all parking and loading areas, including driveways, shall be paved, except in the "M-1" and "M-2" zoning districts where the Department may approve a chip and seal surface treatment (see Section 3.10.1.5.3).

3.10.1.5.2 Surfacing and Curbing. All off-street parking areas and access drives, except those serving one or two-family residences, shall be constructed to the standard of minor streets as defined in Section 3.1.3 above.

3.10.1.5.3 In the M-1 and M-2 zoning districts, this construction standard shall be required for customer, visitor and employee parking. Notwithstanding this construction standard, those areas used for loading docks, parking of commercial vehicles or storage of materials, equipment or products in these districts may be constructed of a ten (10) inch rolled stone base covered with a prime coat having a coverage ratio of 0.5 gallons per square yard of surface area and a finish surface of 3/8 inch dust free trap rock sealed with a seal coat having a coverage ratio of 0.5 gallons per square yard of surface area. The rolled stone base shall be laid on a prepared surface and consist of 8 inches of Type 1 aggregate overlain with 2 inches of Type 2 aggregate.

3.10.1.5.4 All off-street parking areas and all access drives in commercial and industrial zoning districts shall have a boundary constructed of straight-back concrete curbing.

3. STREETS & PARKING

3.10.1.5.5 Off street parking and access drives for one and two-family residences in subdivisions shall be constructed of either four (4) inches Portland cement concrete with two (2) inch rolled stone base or two (2) inch type C Asphaltic concrete with six (6) inch rolled stone base.

3.10.1.6 Maintenance. Off-street parking areas shall be maintained in proper repair with a dust-free surface at the expense of the owner.

3.10.1.7 Drainage Facilities. For any use which will require a parking area to be newly constructed, added to, or altered in such a way as to affect drainage either on or off the site, as determined by the Commissioner of Public Works, storm water drainage plans, including grading plans, shall be submitted to and approved by the Commissioner, prior to the issuance of a building permit or commercial use permit.

3.10.1.8 Permit Required. No person, firm, or corporation shall initiate construction of a new parking lot, or expansion of an existing parking lot, without first obtaining a permit for such development from the Building Commissioner. Application for a permit shall be made upon the form provided and shall be accompanied by such information, plans and specifications as may be required. A permit shall not be required for resurfacing an existing parking area or for driveways for single-family and two-family residential dwellings.

3.10.1.9 All non-residential off-street parking and loading spaces shall be striped.

3.10.1.10 Setback Requirements

3.10.1.10.1 Off-street parking for single-family and two-family residential uses shall have no setback requirements.

3.10.1.10.2 In a commercial or industrial district, parking space provided in an unenclosed area shall not be closer to the street right-of-way than fifteen (15) feet, but may be located on any other part of the lot in conformance with zoning regulations. The area between the street right-of-way and front yard line, except for required driveways, shall be landscaped and such landscaping shall be adequately maintained. A ten (10) foot side and rear setback shall be maintained if the parcel abuts areas zoned for agricultural, or is zoned or used for residential purposes.

3.10.1.10.3 Off-street parking for all other uses, including multi-family residential, commercial and industrial, shall have a setback requirement of 10 feet from the front property line. A ten (10) foot side and rear setback shall be maintained if the parcel abuts areas zoned for agricultural, or is zoned or used for residential purposes.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.10.1.10.4 The area between the property line and the parking setback line shall be used for landscaping and/or screening as required by the Zoning and Subdivision Code, Section 400.230, "Landscaping and Screening."

3.10.1.11 Location of Parking Areas. Off-street automobile parking facilities shall be located as follows:¹

a.) For one and two-family dwellings - on the same lot as the building they are required to serve.

b.) For three and four-family dwellings - on the same lot or parcel of land as the building they are required to serve. For the purpose of this requirement, a group of such uses constructed on contiguous lots or parcels and maintained under single ownership or management shall be assumed to be on a single lot or parcel of land.

c.) For apartment houses containing four (4) or more dwelling units - on the same lot or parcel of land as the building they are required to serve, or on a separate lot or parcel of land not more than three hundred (300) feet from the nearest entrance of the main building being served, provided the lot or parcel of land selected for the parking facilities is located in a multi-family, or less restrictive, district.

d.) For churches, hospitals, sanitariums, homes for the aged, convalescent homes, and other similar uses - the off-street parking facilities required shall be on the same lot or parcel of land as the main building or buildings being served or upon properties contiguous to that lot or parcel.

e.) For uses other than those specified above, including commercial and industrial - off-street parking facilities shall be provided on the same lot or parcel of land as the main building being served, or on a separate lot or parcel of land not more than five hundred (500) feet from any entrance to the main building, provided the separate lot or parcel of land intended for the parking facilities is located in the same, or a less restrictive, district as the principal permitted use.

3.10.1.12 Screening of Parking Areas. Parking areas shall comply with the Zoning and Subdivision Code, Section 400.230, "Landscaping and Screening."

3.10.1.13 Lighting of Parking Areas. Any lights used to illuminate the parking area shall be arranged, located or screened to direct light away from any adjoining residential use.

3.10.1.14 Additional Parking Requirements. Parking facilities shall also comply with the following:

¹ Where a distance is specified, such distance shall be measured from the nearest point of the parking area to the nearest entrance of the building that the parking area is required to serve.

3. STREETS & PARKING

a.) Head-In Parking. Except for single-family and two-family residential use, head-in parking from any public right-of-way, which would allow traffic to back out directly into the public right-of-way, shall not be permitted.

b.) Off-street parking, not required under this Section, but voluntarily provided, shall comply with all requirements in regard to location and construction.

c.) Required spaces shall not be used for storage and shall be kept available for their parking function.

d.) Curbed islands are required at ends of aisles where necessary for traffic control or drainage.

e.) All required parking spaces shall be located out of the flood plain.

3.10.2 Loading

3.10.2.1 General. Any business or industrial building, hospital, institution, or hotel hereafter constructed, reconstructed, or expanded, in any district, shall provide adequate off-street facilities for the loading and unloading of merchandise and goods within or adjacent to the building, in such a manner as not to obstruct freedom of traffic movement and parking on the public streets or alleys.

3.10.2.2. Loading Docks.

Loading docks shall be designed so that trucks shall not be forced to maneuver on public or private streets. A paved area of seventy-five (75) feet in depth (not including public or private street right-of-way) as measured at right angles to the loading dock shall be required for proper maneuvering of large vehicles.

3.10.3. Accessible Parking Space Requirements

3.10.3.1. When parking lots or parking garage facilities are provided, the number of accessible parking spaces shall be provided in accordance with Table 3-10.

3.10.3.2. Location. Accessible parking spaces shall be located on the shortest possible accessible route of travel to an accessible building entrance. In facilities

Table 3-10
Accessible Parking Space Requirements

Total Parking Spaces Required in Lot	Minimum Number of Accessible Spaces Required
1 - 25	1
26 - 50	2
51 - 75	3
76 - 100	4
101 - 150	5
151 - 200	6
201 - 300	7
301 - 400	8
401 - 500	9
501 - 1,000	2% of total spaces
Over 1,000	20 spaces plus 1 space for every 100 spaces, or fraction thereof, over 1,000

PACIFIC DESIGN & CONSTRUCTION STANDARDS

with multiple accessible building entrances with adjacent parking, accessible parking spaces shall be dispersed and located near the accessible entrances. When practical, the accessible route of travel shall not cross lanes for vehicular traffic. When crossing vehicle traffic lanes is necessary, the route of travel shall be designated and marked as a crosswalk.

3.10.3.3. Design and Construction. Accessible parking spaces shall be designed and constructed in accordance with the following dimensions:

- a.) An accessible parking space shall be a rectangle which is a minimum of 12 feet 6 inches wide by 19 feet deep, placed at the prescribed angle so that it lies between the curb and the aisle; or
- b.) An accessible parking space shall be constructed to the required dimensions with an adjacent access aisle of not less than 5 feet wide.
- c.) Accessible parking spaces shall be located on a surface with a slope not exceeding 1 vertical in 50 horizontal.

3.10.3.4. Signs. Every accessible parking space shall be identified by a sign, mounted on a pole or other structure between 3 feet and 5 feet above the parking surface, at the head of the parking space. The sign shall be at least 12" by 18" in area and in conformance with the requirements set forth in the Manual on Uniform Traffic Control Devices, as referenced in Section 315.020 of the Municipal Code of the City of Pacific.

3.10.3.5. Method of Computation. Accessible parking spaces shall be counted as part of the total minimum number of parking spaces required.

3.11. GEOTECHNICAL REPORT

3.11.1 A Geotechnical Report may be required by the Commissioner where grading and proposed improvements on the site are located in an area where soil conditions are susceptible to rapid erosion, landslide, settlement, and/or creep, poor shrink-swell characteristics, or have other unfavorable characteristics as defined by the Natural Resource Conservation Service Soil Survey (formerly the Soil Conservation Service). Said subsurface investigation may be required by the Commissioner at any time prior to the approval of the final plat or any time thereafter and shall be paid for by the developer. The report shall verify the adaptability of grading and improvements with soil and geologic conditions. A statement of compliance with said geotechnical study, signed by the Geotechnical Engineer preparing the report, shall be included on all Site Development Plans. The development plan and improvement plans shall be designed to conform to the requirements and conditions of the Geotechnical Report. A Geotechnical Engineer shall be required to inspect construction in accordance with the grading and soils requirements and conditions contained in the report.

3. STREETS & PARKING

3.11.2 In general, all slopes shall be graded to meet the City's standard 3:1 or flatter slope for both cut and fill. If the preliminary grading plans or site plans propose high terraces, the soils report should indicate measures to intercept and divert surface water from flowing over terraces and walls.

3.11.3 In all areas of questionable soil stability such as sinkholes, ponds, marshy areas, etc., the Department shall be notified prior to commencement of grading so that these locations can be inspected.

3.11.4 In preparing geotechnical reports, the consultant should prepare conditions within the report covering the following, at a minimum, as applicable:

3.11.4.1 Erosion of silt-rich loessial soil: A section in the report shall discuss what best management practices will be followed to minimize surface erosion during and after construction. The section should also discuss what measures should be taken to address erosive velocities at discharge points.

3.11.4.2 Developments on slopes greater than 20%: Soil creep is a potential problem on slopes this steep, and developments in these areas will require engineering analysis and solutions.

3.11.4.3 Cut and fill: Construction of cut and fill slopes should be detailed to assure slope stability.

3.11.4.4 Natural slope stability: A section in the report shall address stability of natural slopes. If slopes are founded on shale, discuss if the slopes are stable enough for the development/construction proposed.

3.11.4.5 Swelling soils, high plastic clays: The potential for swelling of soils and their affect on structure and road foundations should be discussed.

3.11.4.6 Additional considerations that can be covered in these reports include affect of stream erosion on private property, foundation design, foundation drainage, road design, excavations, etc.

3.11.4.7 The reports for the erosion-prone area do not necessarily require subsurface investigation. The shale areas, however, would almost certainly require shallow exploration. The reports shall be prepared under the supervision of and sealed by an engineer.

3.11.5. Developments that require more detailed soils information are those with very dense housing (greater than 3-4 houses per acre), extensive grading and site preparation (including cut and fill), steep slopes, soils with poor structural characteristics e.g. high plastic clays, etc. Some developments can be less critically reviewed due to minimal site disturbance and low density housing (2 or less houses per acre).

PACIFIC DESIGN & CONSTRUCTION STANDARDS

3.12 OTHER REQUIREMENTS

3.12.1. Noise Pollution. It is possible that substantial sound levels may be present for a development site located adjacent to a Federal Aid highway, and acceptable noise levels established by the Federal Highway Administration for the Federal-Aid System may be exceeded. A noise study evaluating the impact of existing and proposed traffic on the development should be provided. Certain noise abatement criteria established by the Federal Highway Administration must be followed in developing the site

3.12.2. Fire Station Signals. When fire station signals are required by the Department, installation and material costs shall be the responsibility of the developer.

3.12.3. Steep Grade Justification

3.12.3.1 Street grades exceeding 8% are considered not desirable. If street grades exceeding 8% are proposed, a separate plan submittal is required requesting steep grade approval. This plan submittal shall include as a minimum:

- a.) Plan and profile sheets showing the proposed grade, an 8% grade and giving the street names and stationing.
- b.) Existing ground line and rock line based on actual field borings and survey.
- c.) Cross sections, including rock elevations, at critical locations to determine the grading of adjacent lots.
- d.) Cost estimates of rock excavation required to obtain an 8% grade versus the proposed grade.
- e.) Earthwork quantities and cost estimates required to obtain an 8% grade versus the proposed grade.
- f.) Cost estimate of hauling operation if earthwork balance cannot be obtained by using 8% grades.

3.12.3.2 The following will not be considered as justification for steep grade approval:

- a.) Inability to obtain the total number of lots permitted by zoning.
- b.) Adhering to previously approved flood plain study.
- c.) Removal of tree cover.

3. STREETS & PARKING

d.) Variance from standard typical sections.

3.12.3.3 Approval of steep grades exceeding 8% will be given by the Commissioner based on the data submitted.

3.12.3.4 When steep grades are approved, steep grade provisions shall be included, and pavement lugs installed where required.

3.12.3.5 Standard platforms ranging from 2% to 4% for sixty (60) feet will be required at all side street intersections regardless of steep grade approval.

3.12.4 Retaining Walls

3.12.4.1 Railroad Tie Walls are not permitted in the City.

3.12.4.2 Reinforced concrete retaining walls are required for all roadway fills.

3.12.4.3 Alternate retaining wall systems will be considered such that the design drawings and calculations thereof are sealed by a Professional Engineer registered in the State of Missouri. One such alternate is a wall that utilizes a geogrid soil reinforcement along with modular concrete retaining wall units (e.g. Keystone, Versa-Lok, etc.). Final design of any alternate type system shall be based upon adequate site investigations by a qualified Soils Engineer.

3.12.5 Subgrade & Base Construction

3.12.5.1 Prior to beginning construction, all necessary clearing, grubbing and scalping in fill areas shall have been performed. Excavation shall be made to the designated alignment, grade and cross section. Cut and fill areas shall be finished to a reasonably smooth and uniform surface that will merge with the adjacent terrain. Areas disturbed by the Contractor outside the limits of construction shall be restored at the Contractor's expense to a condition similar to that prior to construction operations. Siltation control devices will need to be used to control erosion.

3.12.5.2 Embankment construction shall consist of placing and compacting approved materials within areas where unsuitable material has been removed, and placing and compaction of embankment material in holes, pits, and other depressions. Only approved materials free of trees, stumps, rubbish, and any other deleterious material shall be used in the construction of embankments and backfills.

3.12.5.3 Where excavation results in a subgrade or slopes of unsuitable material, the unsuitable material will be removed and backfilled to the finished graded section with approved material. During the process of excavation, the geotechnical engineer

PACIFIC DESIGN & CONSTRUCTION STANDARDS

may order specific excavated material be placed in stockpiles in order to have suitable material available to backfill portions of undergraded cuts.

3.12.5.4 Construction shall not be started on foundation soil having more than 0.2 foot of frost, nor shall frozen material be used. No material shall be placed on frost layers encountered within 12 inches of the top of the proposed section. Frozen material on foundation soil or partially completed embankment not meeting the above requirements shall be removed before placing further material.

3.12.5.5 All excess or unsuitable excavated material, including rock and boulders that cannot be used in the embankment shall be stored in designated storage areas or as directed by the engineer, and later used as fill in uncritical areas or removed from the site.

3.12.5.6 Embankment materials and base material shall be placed in layers 6 to 8 inches in thickness (loose measurement) and compacted to a minimum dry density of ninety-five percent (95%) Standard Proctor density for the material used as determined by a soil testing firm.

3.12.5.7 The moisture content of the compacted fill shall be between 2% below and 4% above the optimum moisture content. The field density of the embankment after compaction will be determined in accordance with ASTM D2922 (Nuclear Method), ASTM D1556 (Sand Cone Method), ASTM D2167 (Rubber Balloon Method), or ASTM D2937 (Drive Cylinder Method). The volume of the test hole may be reduced as necessary to accommodate available testing equipment. The calculated density obtained in the field density test will be compared with the maximum dry density as established by the Standard Proctor test to determine the percent compaction attained. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. Continuous leveling and manipulating will be required during compaction operations.

3.12.5.8 The optimum moisture as determined by the Standard Proctor test shall be used as a guide in determining the proper moisture content at which the soil shall be compacted. Field moisture control may be achieved by ASTM D3017 (Nuclear Method), as well as those tests listed above. Water shall be added or removed as necessary to permit obtaining the required density. The moisture content of the soil at the time of compaction shall be within the range designated.

3.12.5.9 Each layer shall be wetted or dried, if necessary, and shall be compacted to the required density. Regardless of the type of equipment used, the fill shall be compacted uniformly and the surface kept reasonably smooth at all times. When large pieces of heavy clay are encountered, the material shall be broken down by suitable manipulation to permit satisfactory construction.

3.12.5.10 The compactive effort on each layer shall consist of distributing all equipment movements over the entire fill area and making at least three complete coverages

3. STREETS & PARKING

with a tamping-type roller. The tamping-type roller shall have tampers or feet projecting not less than 6 inches from the surface of the drum and shall have a minimum load on each tamper of 250 pounds per square inch of tamping area.

3.12.5.11 Field density tests must be performed on each lift of fill, including base, to verify that proper compaction is achieved.

3.12.5.12 In no case shall fill material be placed on an area that has not been tested or on an area that has failed to meet the compaction requirements. In the case fill is placed over an area that has not passed compaction tests, the Commissioner or engineer may order the material be removed.

3.12.5.13 Newly finished subgrade and base shall be protected from any action of the elements, or any settlement or washing that occurs prior to placing aggregate base and shall be repaired to the specified line, grade and cross-section.

3.12.5.14 Compaction tests shall be the responsibility of the developer as a form of Quality Control. Tests shall be taken by an approved Engineer or testing firm, at no cost to the City and at locations approved by the Department but at distances no greater than two hundred (200) feet apart. The City may, at the discretion of the Commissioner, employ a testing firm as a form of Quality Assurance.

3.12.5.15 It shall be the responsibility of the developer to remove and replace unsuitable material in order to meet compaction requirements.

3.12.6 Backfill Under Pavements. All excavations for sewers and for public utilities made under existing pavements or areas proposed to be paved shall be carefully backfilled with granular material. The material to be Type 2 or Type 3 aggregate per Section 8.1, or other material approved by the Commissioner, and thoroughly compacted in lifts not exceeding 8 inches, loose measure, in such a manner as to inhibit any settlement of the finished pavement. Such excavations made in existing paved areas shall be made in accordance with the requirements and regulations of 525.140 et seq., "Excavations", of the Municipal Code of the City.

3.12.7 Blocks

3.12.7.1 Blocks shall not exceed nine hundred (900) feet in length.

3.12.7.2 Blocks shall be of sufficient width to permit two (2) tiers of lots of appropriate depth, except where an interior street parallels a limited access highway or railroad right-of-way.

3.12.7.3 Pedestrian walkways between blocks are prohibited. Pedestrian walkways are permitted to obtain access to common area so long as said walkway is in connection with an access drive.

3.12.8 Underground Utility lines.

3.12.8.1 All electric, cable television, telephone and similar data and utility transmission lines primarily intended for the use of buildings and structures located within the City of Pacific shall be installed underground for new construction and for any rehabilitation where improvement costs exceed \$100,000.00.

3.12.8.2 All electric, cable television, telephone and similar data and utility transmission lines shall be installed in conformance with the standards and specifications of the particular utility company involved. They shall be located within easements or public rights-of-way in a manner which will not conflict with other utilities or services.

EXHIBIT NO. 1

CROSS ACCESS EASEMENT AGREEMENT

THIS AGREEMENT, made and entered into this ___ day of _____, owner of a tract of land described in Deed Book _____, Page _____ of the _____ County Records, party of the first part and _____, owner of a tract of land described in Deed Book _____, Page _____ of said County Records and _____, owner of Lot _____ of _____, a subdivision according to the plat thereof, recorded in Plat Book _____, Page _____ of said County Records, parties of the second part.

NOW, THEREFORE, it is the desire of the party of the first part to grant to the parties of the second part and to their respective successors and assigns, their tenants, subtenants, licensees, and the respective officers, employees, agents, representatives, customers and invitees, the nonexclusive right, privilege and easement to use drives and roads as may now or from time to time hereafter be situated on the property of the party of the first part for ingress and egress to the property of the parties of the second part, and to the public road by automobile or other passenger vehicle. Said easement being fully described on Exhibit "A" attached hereto and incorporated herein by reference. Said easement shall be perpetual, and further, shall run with the real estate of the party of the first part forever. The party of the first part agrees not to obstruct the aforesaid roadway by means of a fence or other barrier, and further, to keep a road open and usable on their property leading from the aforesaid roadway to the public road so that there will be continuing access to the public road through the real estate of the party of the first part. No such accessway shall be relocated, narrowed or otherwise altered without the approval of the City of Pacific Departments of Planning and Zoning on a revised circulation plan and the easement hereby established shall apply fully to such altered accessway.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

EXHIBIT NO. 1 (Continued)

IN WITNESS WHEREOF, the said part____ of the first part ha____ executed these presents the day and year first above written.

(Corporation)

Attest: _____

(SEAL) Secretary _____

STATE OF MISSOURI)
)SS.
COUNTY OF _____)

On this _ day of _____, 19____, before me personally appeared _____ to me known to be the person(s) described in and who executed the foregoing instrument, and acknowledged that _____ executed the same as _____ free act and deed.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

My term expires: _____

Notary Public

STATE OF MISSOURI)
)SS.
COUNTY OF _____)

On this _ day of _____, 19____, before me personally appeared _____ to me known who, being by me duly sworn, did say that he is the _____ of _____, a Corporation of the State of _____, and that the seal affixed to the foregoing instrument is the corporate seal of said corporation, and that said instrument was signed and sealed in behalf of said corporation, by authority of its Board of Directors; and said _____ acknowledged said instrument to be the free act and deed of said corporation.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal in the County and State aforesaid, the day and year first above written.

My term expires: _____

Notary Public

Preparation Notes:

The second paragraph on previous page makes reference to an "attached Exhibit". This attachment can be provided by developing an Instrument Plat pursuant to the requirements shown on the following page.

The Cross Access Easement Agreement shown above may be copied, pasted or taped together to measure 8-1/2" x 14" and duplicated for execution and recording in the office of the Recorder of Deeds.

Any modification of the Cross Access Easement Agreement shall be reviewed by the City Counselor and Departments of Planning and Zoning, Public Works and or the Zoning Enforcement Officer and approved prior to execution and recording.

EXHIBIT NO. 1 (Continued)

Instrument Plat or Exhibit Format

This form has been provided to show the format of the plat or exhibit to accompany dedication instruments or special escrow documents and may be copied, pasted or taped together to measure 8-1/2" x 14" and duplicated for insertion of the plat information or plan coverage in this space.

Plat preparation shall conform to the applicable requirements of the Subdivision Code. Use of this form as an Instrument Plat requires the right-of-way, easement or license area to be identified with hatching on the plat and in the boxed space provided within the instrument.

This page is intentionally blank

SECTION 4
WASTEWATER

4. WASTEWATER

4.1 GENERAL. This section gives the minimum technical design requirements of the City of Pacific, Missouri for sanitary sewerage and sewage treatment facilities. In general, the formulas presented herein for hydraulic design represent acceptable procedures not necessarily to the exclusion of other sound and technically supportive formulae. All construction details pertaining to sanitary sewer improvements shall be prepared in accordance with the Design and Construction Standards of the City of Pacific unless otherwise noted.

4.2 SEWAGE FLOW AND STRENGTH

4.2.1 Population to Be Served. Values in Table 4-1 shall be used in determining the population for which to design all sewage works including treatment systems, sewers, and pumping stations.

4.2.2 Sewage System Design Loadings. Values contained in Table 4-2 shall be used as minimum design loadings for all treatment processes and sewage works. The quantities shown are average values to be used in computations. A peaking factor of four (4) can be applied to obtain maximum daily sewage flows.

4.2.3 All sewers, including house laterals, shall be designed on the basis of values derived from Table 4-1 and Table 4-2. Sanitary flow from all other types of institutions shall be separate and individual studies based on a conservative ultimate anticipated flow multiplied by the peak factors applicable to each case. In the case of industrial flow, when the rate and volume can be predetermined with a reasonable degree of accuracy, no dilutions or diminishing factor shall be applied against this flow in the outfall, sub-trunk or trunk sewers.

4.3. GENERAL REQUIREMENTS FOR SANITARY SEWER CONSTRUCTION. All sanitary sewers shall meet the following general requirements:

4.3.1. Size and Shape of Pipe. The minimum diameter of pipe for gravity sanitary sewers shall be eight (8) inches. Sewers shall not decrease in size in the direction of the flow. Circular pipe sewers shall be used for all sizes of sanitary sewers.

4.3.2. Materials. All materials shall conform to Standard Construction Details contained in Section 9.

4.3.3. Gravity Pipe. All gravity pipe and fittings shall, at a minimum, comply with ASTM D 3034, SDR35 if PVC pipe or AWWA C151, Class 150 if ductile iron pipe. Wall thickness shall be as determined from structural calculations and/or other considerations that might affect pipe thickness.

Table 4-1

Population to be Served

Type of Unit	Persons/ Unit
Residences	3.7
Apartments or Condominiums:	
(1 bedroom)	2.1
(2 bedroom)	3.0
(3 bedroom)	3.7
Mobile Homes	3.7
Camper Trailer	3.0
Motels	3.0

**Table 4-2
Sewage Flow and Strength Loading**

Type of Establishment	BOD, Lb./ person/day	Flow, gal./ person/day
Residential		
Single family dwellings	0.17	100
Apartments or condominiums	0.17	100
Rooming houses	0.17	45
Boarding houses	0.17	75
Mobile homes	0.17	100
Industrial *		
Employee sanitary waste	0.05	15
Food or Drink Establishments (wastes per patron)		
Tavern or bar (not serving food)	0.01	2
Fast food (paper service)	0.02	3
Cafe or restaurant	0.03	5
Restaurant serving alcoholic beverages	0.04	5
Restaurant grinding garbage	0.07	6
Schools (wastes per student)		
Day school, no cafeteria, gym or showers	0.02	10
With cafeteria - ADD	0.02	4
With garbage grinding - ADD	0.02	1
With gym and showers - ADD	0.01	10
Boarding schools	0.17	75
Institutions		
Hospitals (per bed)	0.22	150
Institutions other than hospitals	0.17	125
Nursing homes	0.17	125
Commercial and Recreational		
Public parks (toilets only)	0.02	5
Public parks (with bath house, showers, toilets)	0.06	20
Swimming pools and beaches	0.06	20
Country clubs (per resident member)	0.17	100
Country clubs (per member present)	0.06	20
Service stations (per customer)	0.01	5
Laundromats (per machine)	1.25	580
Hotels	0.15	50
Motels (without restaurants)	0.10	40
Luxury resorts	0.17	75
Camper trailers	0.08	30
Work or construction camps	0.15	60
Churches (per seat)	0.01	5
Stores, malls or shopping centers (per one thousand square feet of floor area)	0.34	200
Stadiums, auditoriums, theaters (per seat)	0.01	5

4.3.4. Pressure Pipe. Pressure pipe and fittings shall be either PVC or Ductile Iron. PVC pipe shall comply with either AWWA C900, DR 14 or ASTM D2241, SDR 13.5. If ASTM D2241, material shall be PVC 1120, PVC 1220 or PVC 2120, all with a design stress of 2000 psi. Ductile Iron pipe shall comply with AWWA C151 Thickness Class 51. All appropriate thrust blocking shall be provided as shown and described in Section 6. Water Supply.

4.3.5. Trenching and Bedding

4.3.5.1 The project Plans and Project Specifications shall indicate the specific type or types of bedding, cradling, or encasement required in the various parts of the sanitary sewer construction. Trenching and bedding of all piping shall be as shown on Design Details PIP.01, PIP.02, and PIP.03.

4.3.5.2 Special provisions shall be made for pipes laid under or over fills or embankments in shallow or partial trenches either by specifying extra strength pipe for the additional loads due to differential settlement, or by special construction methods to prevent or to minimize such additional loads.

4.3.5.3 Pipes having a cover of less than 30 inches over the crown shall be encased in concrete, unless otherwise approved by the Department.

4.3.5.4 If storm and sanitary sewers are parallel and in the same trench, the upper pipe shall be placed on a shelf and the lower pipe shall be bedded in Type 1, Type 2 or Type 3 compacted granular fill to the flow line of the upper pipe.

4.3.6. Pipe or Conduit Under Streets and Pavements. Any pipe or conduit material beneath a highway, road, street, or pavement, or with reasonable probability of being so located, shall have ample strength for all vertical loads, including the live load required by the highway authority having jurisdiction, and in no case shall provide for less than an AASHTO HS-20 loading. For other locations, the minimum live load shall be the HS-10 loading. Special considerations may be required for adverse conditions. Compacted granular backfill shall be utilized to the base of the pavement as shown on Design Details PIP.01, PIP.02, and PIP.03.

4.3.7. Joints. Joints used with PVC pipes shall be elastomeric gasket joints providing a water tight seal. They shall conform to the requirements of ASTM D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals. Joints used with Ductile Iron Pipes shall conform to the requirements of AWWA C111, Standard for Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings. Joint types shall be designated on the construction drawings.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

4.3.8. Alignment. Sanitary sewer alignments are normally limited by the available easements which in turn should reflect proper alignment requirements. Sanitary sewers shall be aligned:

a.) To be in a straight line between manholes or other structures for all pipe sewers thirty inches (30) in diameter and smaller.

b.) To be parallel with or perpendicular to the centerlines of straight streets unless otherwise unavoidable. Deviations may be made only with approval of the Commissioner.

c.) To avoid meandering, off-setting and unnecessary angular changes.

d.) To make angular changes in alignment for sewers thirty (30) inches in diameter or smaller in a manhole located at an angle point and for sewers thirty-three (33) inches in diameter or larger, by a uniform curve between two tangents. Curves shall have a minimum radius of ten times the pipe diameter. To avoid angular changes in direction greater than necessary and any exceeding ninety (90) degrees.

4.3.9. Location. Sanitary sewer locations are determined primarily by the requirements of service and purpose. It is also necessary to consider accessibility for construction and maintenance, site availability and competing uses, and effects of easements on private property. Sanitary sewers shall be located:

a.) To serve all property conveniently and to best advantage.

b.) In public streets, roads, alleys, rights-of-way, or in sewer easements dedicated to the City.

c.) In easements on private property only when unavoidable.

d.) On private property along property lines or immediately adjacent to public streets, avoiding crossing through the property.

e.) At a sufficient distance from existing and/or proposed buildings (including footings) and underground utilities or other sewers to avoid encroachment and reduce construction hazards.

f.) To avoid interference between house connections to sanitary sewers, stormwater sewers and water supply lines.

g.) In unpaved or unimproved areas whenever possible.

h.) To avoid, whenever possible, any locations known to be or probably to be beneath curbs, paving or other improvements particularly when laid parallel to centerlines.

- i.) To avoid sinkholes and creeks.

4.4. GRAVITY SEWERS

4.4.1. Flowline. The flowline of gravity sanitary sewers shall meet the following requirements:

- a.) The flowline shall be straight or without gradient change between the inner walls of connected structures.

- b.) Gradient changes in successive reaches normally shall be consistent and regular, with small or insignificant differences in successive reaches. Gradient designations less than the nearest 0.001 foot per foot, except under special circumstances and for larger sewers, shall be avoided.

- c.) Sewer depths shall be determined primarily by the requirements of pipe or conduit size, utility obstructions, required connection, future extensions, and adequate cover.

- d.) For gravity sanitary sewers, the hydraulic grade line shall not rise above the intrados of the pipe.

- e.) When the grade of a sewer is twenty (20) percent or greater, a concrete cradle or collars is required. For grades exceeding fifty (50) percent a special design and Project Specifications are required.

4.4.2. Manholes. Manholes provide access to sewers for purposes of inspection, maintenance and repair. They also serve as junction structures for connecting lines. Requirements of sewer maintenance determine the main characteristics of manholes. The manholes in sanitary sewers shall meet the following requirements:

- a.) Manholes shall be pre-cast concrete conforming to ASTM C478 *Standard Specification for Precast Reinforced Concrete Manhole Sections* and Design Details MH.01, MH.02, MH.03 and MH.04. The inside diameter of manholes shall not be less than forty-eight (48"). Manhole covers and frames shall be cast iron conforming with Design Details MH.07 and MH.08.

- b.) Manholes shall be located at changes in direction, changes of pipe size, flowline gradient, and at junction points with connecting sewers. For sewers thirty-three (33) inches in diameter and larger, manholes shall be located on special structures at junction points with other sewers and at changes of size or gradient.

- c.) Spacing of manholes shall not exceed four hundred (400) feet for pipe sewers thirty-six (36) inches in diameter and smaller, five hundred (500) feet for pipe sewers forty-

PACIFIC DESIGN & CONSTRUCTION STANDARDS

two (42) inches in diameter and larger, except under special approved conditions. Spacing shall be approximately equal, whenever possible.

4.4.3 Cleanouts. Cleanouts can only be used at the head of a minor sewer line. If a cleanout is used, it shall conform to Design Detail MH.09.

4.4.4. Design Requirements

4.4.4.1 General. All gravity sanitary sewers shall be so designed and constructed as to conform to these design requirements.

4.4.4.2 Gradients. The minimum slopes of sanitary pipe sewers are contained in Table 4-3. These slopes give velocities of at least 3 feet per second flowing full, based on Manning's formula using an "n" value of 0.013. Slopes greater than these minimums shall be used wherever possible. Pipes larger than thirty (36) inches in diameter shall maintain a cleansing velocity of three (3) feet per second.

4.4.4.3 Depth

4.4.4.3.1 The minimum depth of collecting and lateral sewers should be nine (9) feet below the finish street grade to flowline except where the topography indicates this depth is not necessary. Where the nine (9) feet depth is not required, the minimum vertical distance from the low point of a basement or low floor to the flowline of a sanitary sewer at the corresponding house connection shall be not less than the diameter of the sewer plus a vertical distance of two and one-half (2 1/2) feet. This minimum vertical distance shall be increased, if the length of the lateral requires, to obtain a minimum slope of two (2) percent for six (6) inch house laterals. These minimum depths will not apply to interceptor sewers in low areas whose only function is to carry off the accumulated flow to existing or proposed trunk sewers.

Table 4-3
Minimum Pipe Slopes for
Gravity Sewers

Pipe Size, in.	Minimum Slope, ft. per 100 ft. (% Grade)
8	1.0
10	0.6
12	0.5
15	0.4
18	0.3
21	0.3
24	0.2
27	0.2
30	0.2
36	0.1

4.4.4.3.2 All collecting and outfall, sub-trunk and trunk line sewers in low areas in close proximity to natural watercourses shall be constructed at depths low enough to permit all proposed and existing connecting lateral sewers to make the channel crossing so as to have at least three (3) feet of cover over the top of the lateral pipe. All sanitary sewers crossing streams or channels shall be a minimum of three (3) feet below the natural stream bottom. Additionally, sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible. Sewers entering or crossing streams shall be constructed of cast iron or ductile iron pipe with mechanical joints or shall be constructed so they will remain watertight and free from displacement. A manhole shall

4. WASTEWATER

be provided within ten (10) feet from top of bank on both sides of a crossing. All sanitary sewers shall be laid deep enough to allow for future extension of the system to fully serve the watershed. The foregoing depth requirements may be modified in special cases when such modifications are feasible and will not jeopardize the design when considered as an integral part of an overall system. All modifications shall be approved by the Commissioner.

4.4.5 Hydraulic Grade Line

4.4.5.1 Hydraulic Grade Line Limits. The hydraulic grade line for sanitary sewers shall not rise above the pipe intrados. The beginning point for the hydraulic grade line computations for connection to existing pipe systems shall be the higher elevation of:

a.) Top of pipe intrados of one reach downstream of the connection point of the existing system; OR

b.) The hydraulic grade line computed for the existing system.

4.4.5.2 Computation Methods. Sanitary sewers shall be designed to flow full or partially full. The hydraulic grade line shall be computed to show its elevation at manholes, transition structures, and junction points of flow in pipes, and shall provide for the losses and the differences in elevations as required below.

a.) Friction loss. The major energy loss in a sanitary sewer will be the energy loss due to friction. It is determined by the equation:

$$h_f = L \times S_h$$

Where:

- h_f = difference in water surface elevation, (head) in feet in length L
 L = length of pipe, ft.
 S_h = hydraulic slope required for a pipe of given diameter and for a given roughness "n", expressed as feet of slope per foot of length.

From Manning's formula:

$$S_h = \left(\frac{V \cdot n}{1.486 \cdot R^{0.667}} \right)^2$$

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Where:

- R = hydraulic radius of pipe or conduit in feet
V = velocity of flow in feet per second
n = Manning's value for coefficient of roughness; where
 n = 0.013 for concrete, vitrified clay and plastic pipe;
 n = 0.012 for concrete pipe greater than 48 inches in diameter

b.) Curve loss. Curve loss in pipe flow is the additional head required to maintain the required flow because of curved alignment, and is in addition to the friction loss of an equal length of straight alignment. It may be evaluated from Figure 5-2 which includes an example.

c.) Turn loss. Head losses in manholes due to change in direction of flow (turns) will be determined in accordance with the following:

DIAGRAM:

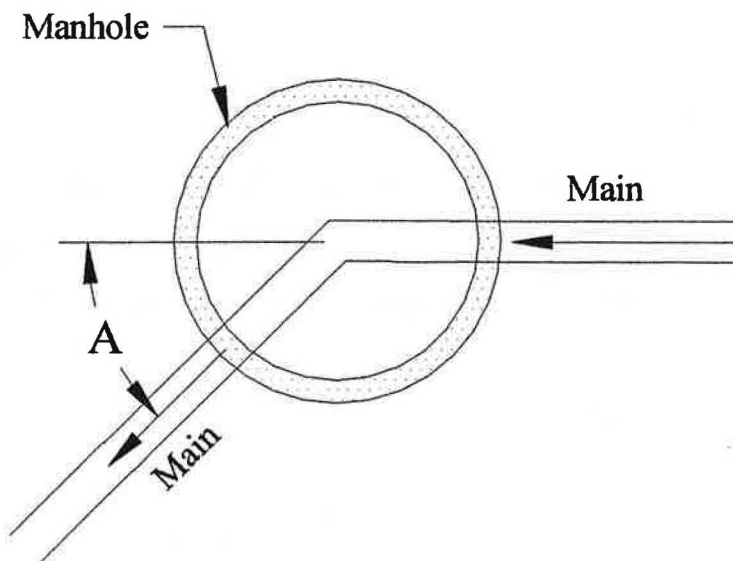


Table 4-4
Turn Loss Factors

Change in Direction of Flow (A)	Multiplier of Velocity Head of Water Being Turned (K)
90 deg.	0.70
60 deg.	0.55
45 deg.	0.47
30 deg.	0.35
15 deg.	0.18
0 deg.	0.00
Other angles	By Interpolation

Formula:

$$H_L = \frac{K \cdot (V_L)^2}{2g}$$

Where:

- H_L = Feet of head lost in manhole due to change in direction of pipe flow
 V_L = Velocity of flow in pipe in Ft/Sec
 g = Acceleration of gravity, 32.2 Ft/Sec/Sec
 K = Multiplier of Velocity Head of water being turned

d.) Junction Chamber loss. A sewer junction occurs for large pipes or conduits too large to be brought together in a forty two (42) inch diameter manhole where one or more branch sewers enter a main sewer. Allowances should be made for head loss due to curvature of the paths and due to impact at the converging streams. Losses in a junction chamber for combining large flows shall be minimized by setting flowline elevations so that pipe centerlines (spring lines) will be approximately in the same planes. At junction points for combining large flows, a manhole with a slotted cover shall be provided. A computation method for determining junction chamber losses is as follows:

$$H_j = \Delta y + (V_{h1} - V_{h2})$$

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Where:

- H_j = junction chamber loss
- Δy = change in hydraulic grade line through the junction in feet
- V_{h1} = upstream velocity head
- V_{h2} = downstream velocity head

And where:

$$\Delta y = \frac{[(Q_2 V_2) - (Q_1 V_1) - (Q_3 V_3 \cos e_3) - (Q_n V_n \cos e_n)]}{0.5 \times (A_1 + A_2)g}$$

Where:

- Q_2 = Discharge in cfs at the exiting conduit
- V_2 = Velocity in fps at the exiting conduit.
- A_2 = Cross sectional area of flow in sq. ft. for the exiting conduit.
- Q_1 = Discharge in cfs for the incoming pipe (main flow).
- V_1 = Velocity in fps for the incoming pipe (main flow).
- A_1 = Cross sectional area of flow in sf for the incoming pipe (main flow)
- Q_3, Q_n = Discharge(s) in cfs for the branch pipe(s).
- V_3, V_n = Velocity(ies) in fps for the branch pipe(s).
- e_3, e_n = The angle between the axes of the exiting pipe and the branch pipe(s)
- g = Acceleration of gravity, 32.2 ft/sec/sec.
- e = The angle between the axes of the outfall and the incoming pipe(s).

The terms within [] indicate the summation of all incoming pipes (not on main sewer).

e.) Losses at Junctions of Several Flows in Manholes. The computation of losses in a manhole with several flows entering the structure should utilize the principle of the conservation of energy. This involves both the elevation of water surface and momentum (mass times the velocity head). Thus, at a manhole with two or more incoming pipes, the sum of the energy content for inflows is equal to the sum of the energy content of the outflows plus the additional energy required by the turbulence of the flows passing through the structure.

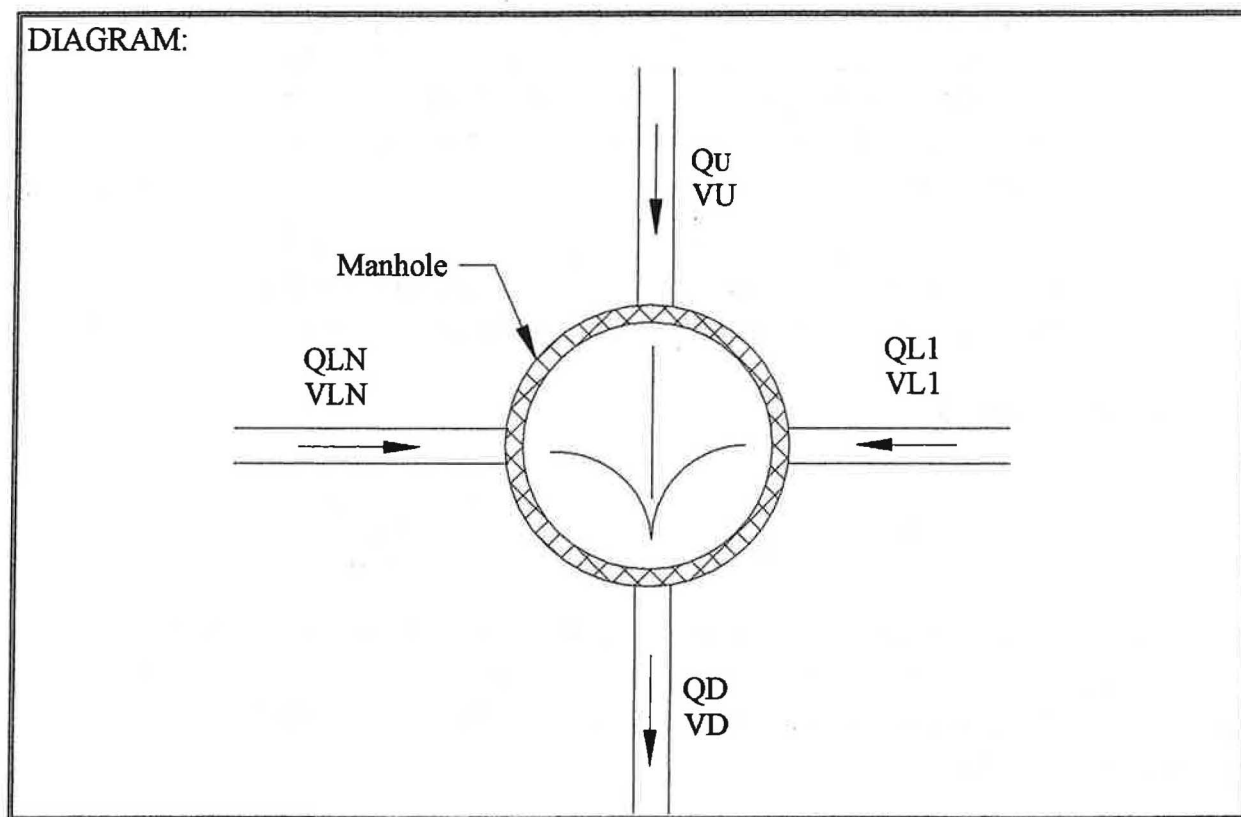
The upstream hydraulic grade line may be calculated as follows:

$$H_u = \left[\frac{V_D^2}{2g} \right] - \left[\left(\frac{Q_U}{Q_D} \right) (1 - K) \left(\frac{V_U^2}{2g} \right) \right] - \left[\left(\frac{Q_{L1}}{Q_D} \right) (1 - K) \left(\frac{V_{L1}^2}{2g} \right) \right] + \left[\left(\frac{Q_{LN}}{Q_D} \right) (1 - K) \left(\frac{V_{LN}^2}{2g} \right) \right] + H_D$$

Where:

- H_u = Upstream hydraulic grade line in feet
- Q_u = Upstream main line discharge in cubic feet per second
- Q_D = Downstream main line discharge in cubic feet per second
- $Q_{L1} - Q_{LN}$ = Pipe discharges in cubic feet per second
- V_U = Upstream main line velocity in feet per second
- V_D = Downstream main line velocity in feet per second
- $V_{L1} - V_{LN}$ = Pipe velocity in feet per second
- H_D = Downstream hydraulic grade line in feet
- K = Multiplier of Velocity of Water being turned
- g = Acceleration of Gravity, 32.2 ft/sec/sec

DIAGRAM:



The above equation does not apply when two (2) almost equal and opposing flows, each perpendicular to the downstream pipe, meet and no other flows exist in the structure. In this case the head loss is considered as the total velocity head of the downstream discharge.

f.) Transition loss

1.) The relative importance of the transition loss is dependent on the velocity head of the flow. If the velocity and velocity head of the flow are quite low, the

PACIFIC DESIGN & CONSTRUCTION STANDARDS

transition losses cannot be very great. However, even small losses may be significant in flat terrain. The sewer design shall provide for the consideration of the necessary transitions and resulting energy losses. The possibility of objectionable deposits is to be considered in the design of transitions.

2.) For design purposes it shall be assumed that the energy loss and changes in depth, velocity and invert elevation, if any, occur at the center of the transition. These changes shall be distributed throughout the length of the transition in actual detailing. The designer shall carry the energy head, piezometric head, and invert as elevations, and work from the energy grade line.

3.) Closed Conduits

i.) Transitions in small sewers may be confined within a manhole. Special structures may be required for larger sewers. The energy loss in a transition shall be expressed as a coefficient multiplied by the change in velocity head ($\Delta V^2/2g$) in which ΔV is the change in velocity before and after the transition. The coefficient may vary from zero to one, depending on the design of the transition.

ii.) If the areas before and after a transition are known, it is often convenient to express the transition loss in terms of the area ratios and either the velocity upstream or downstream.

For an expansion:

$$H_L = K \times \frac{(V_1 - V_2)^2}{2g} = \left\{ K \times \frac{V_1^2}{2g} \right\} \left[1 - \left(\frac{A_1}{A_2} \right) \right]^2$$

in which H_L is the energy loss; K is a coefficient equal to 1.0 for a sudden expansion and approximately 0.2 for a well-designed transition, and the subscripts 1 and 2 denote the upstream and downstream sections, respectively, i.e., A_1 = area before transition and A_2 = area after transition.

For a contraction:

$$H_L = K \times \frac{V_2^2}{2g} \times \left[\left(\frac{1}{C_c} \right) - 1 \right]^2 = \left\{ K \times \frac{V_2^2}{2g} \right\} \left[1 - \left(\frac{A_2}{A_1} \right) \right]^2$$

in which K is a coefficient equal to 0.5 for a well designed transition, C_c is a coefficient of contraction, and the other terms and subscripts are similar to the previous equation. Losses in closed conduits of constant area are expressed in terms of ($V^2/2g$).

The above equations may be applied to approximate the energy loss through a manhole for a circular pipe flowing full. If the invert is fully developed, that is, semi-circular on the bottom and vertical on the sides from one-half depth up to the top of the pipe, for the expansion $A_1/A_2 = 0.88$, and for the contraction $A_2/A_1 = 0.88$. The expansion is sudden; therefore, $K = 1$. The contraction may be rounded if the downstream pipe has a bell or socket. In this case, K may be assumed to be 0.2.

The expansion energy loss is:

$$0.014 [(V_1)^2/2g]$$

and the contraction energy loss is:

$$0.010 [(V_2)^2/2g].$$

Thus it may be seen that if the invert is fully developed, the manhole loss is small.

4.4.6. Infiltration. An additional amount of flow due to infiltration shall be evaluated. All sanitary sewers shall be limited to a maximum of 200 gallons per inch of diameter per day per mile of line, as required by MDNR Specifications, when tested by actual infiltration conditions. In addition, there shall be no visible leaks. All manholes on sanitary sewers that are built within the 100 year flood limits or in other areas determined to be subject to flooding shall be provided with lock-type watertight manhole covers.

4.5. FORCE MAINS (Pressure Sewers)

4.5.1. Material. Force mains shall be constructed of PVC pipe complying with AWWA C900, DR14 or ASTM D2241, SDR13.5, or Ductile Iron pipe complying with AWWA C151 Thickness Class 51. If ASTM D2241, material shall be PVC 1120, PVC 1220 or PVC 2120, all with a design stress of 2000 psi.

4.5.2. Velocity. Velocities adequate to assure scouring should be achieved. At design average flow a velocity of at least two (2) feet per second shall be maintained.

4.5.3. Sewer depths shall be determined primarily by the requirements of pipe or conduit size, utility obstructions, required connection, future extensions, and adequate cover. Top of pipe shall be no less than three (3) feet below the surface.

4.5.4. Cleanouts. Cleanouts provide access to force mains for purposes of inspection, maintenance and repair. They also serve as junction structures for connecting lines. Requirements of sewer maintenance determine the main characteristics of cleanouts. Cleanouts in force mains shall meet the following requirements:

PACIFIC DESIGN & CONSTRUCTION STANDARDS

4.5.4.1 Cleanouts shall be located at changes in pipe size and at junction points with connecting sewers.

4.5.4.2 Spacing of cleanouts shall not exceed five hundred (500) feet except under special approved conditions. Spacing shall be approximately equal, whenever possible.

4.5.4.3 Cleanouts in force mains shall be constructed in accordance with Design Detail MH.06

4.5.4.3 Cleanouts shall be placed in concrete wells or manholes with cast iron frames and covers. Threaded fittings shall be provided to attach pressure lines to blow out obstructions and/or clean sewer pipe.

4.5.5. Air Relief Valves. An automatic air relief valve shall be placed at the high point(s) in the force main to prevent air locking.

4.5.6. Termination. Velocity of flow in the force main should be killed as it enters a receiving gravity manhole. It is preferable that force mains enter the receiving manhole 0.2 foot above the invert out elevation. For small flows (relative to the receiving gravity system), flow can enter in a drop pipe located not more than two (2) feet above the flow line of the receiving manhole.

4.5.7. Design Pressure. Pressure sewer system operating pressures in general should be in the range of 20-40 psi and shall not exceed 60 psi for any appreciable length of time. The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

4.5.8. Hydraulic Analysis

4.5.8.1 Many computer techniques are available today for analyzing hydraulic systems and networks. Use of any method in general use is acceptable but the engineer should submit the details of the method used and the results of computations in report form for review by the Department.

4.5.8.2 The analysis shall show the pressure profile and flow velocity along the sewer line(s) for conditions of minimum, average and maximum flow. The analysis shall demonstrate that all elements of the force main(s) are adequate to withstand pressures imposed on them and that flow velocities are acceptable.

4.5.8.3 Head loss should not exceed the pumping pressure capabilities. Head loss determination should be based on total dynamic head under the maximum flow expected to occur infrequently. Friction losses through force mains shall be based on the Hazen-Williams formula or other acceptable method. When the Hazen-Williams formula is used, the following values for "C" shall be used for design:

a.) unlined iron or steel - 100

b.) all other materials - 120

4.5.8.4 When initially installed, force mains will have a significantly higher "C" factor. The higher "C" factor should be considered only in calculating maximum power requirements.

4.5.9. Identification of Force Mains

4.5.9.1 Where force mains are constructed of material which might be confused with potable water mains, e.g. PVC pipe, the force main shall be identified with tape or other marking that will not deteriorate.

4.5.9.2 Trenches shall be marked with locator tape.

4.6. SEWAGE TREATMENT FACILITIES.

4.6.1. New treatment plants will not be allowed in subdivisions without the approval of the Department, the Commission and the Board of Aldermen. Individual treatment or septic systems will be considered only where the Department determines that no public sanitary sewer is available. Availability of sanitary sewers is assumed if any point on the property to be served is within a distance of two hundred (200) feet of a public sanitary sewer. In any case, the Commissioner will make the final determination based on specific site conditions.

4.7. SPECIAL SITUATIONS AND DESIGN REQUIREMENTS

4.7.1. Connections to Manholes

4.7.1.1 Foulwater drops are required only for sewers containing sanitary flow and then only when it is necessary that sanitary flow enter a manhole at a height more than two (2) feet above its flowline. If an inside drop is to be used, a forty-eight (48) inch diameter manhole is required. Two inside drops are not allowed into one manhole. Sewer lines shall not enter the manhole in the transition conical section, or through a joint. The slope on incoming pipes should be limited to a maximum one percent for inside drops; slopes greater than this require an outside drop structure. Manhole inverts should be shaped to assure proper flow through drop structures. The largest size to be used for an outside drop is 12 inches.

4.7.1.2 If it is necessary to enter a manhole with a force main, this should be done within twelve (12) inches of the flowline of the manhole, and the manhole invert should be shaped to insure proper flow through the structure. Consideration shall be given to

PACIFIC DESIGN & CONSTRUCTION STANDARDS

the detention time of the sewage in the force main, and the potential detrimental effects of the release of hydrogen sulfide from the force main on the concrete structure of the manhole. Where it is determined that the release of hydrogen sulfide may be a problem, the concrete manhole shall be protected by a liner or epoxy coating.

4.7.1.3 The number of lines coming into one manhole should be kept to a minimum. A special detail may be required to assure the proper constructability and maintenance of the structure.

4.7.1.4 Pipes entering and exiting manholes at the flowline should project through the center of the structure and the manhole invert should be shaped to assure proper flow through the structure.

4.7.1.5 Private house lateral connections should be made to the main sewer, not to the manholes. However, lateral connections will be allowed to a terminal manhole. Connections shall be made in accordance with Design Standards PIP.04 through PIP.08.

4.7.1.6 All connections to sanitary manholes are subject to the Department's review and approval and will be made at the Department's discretion.

4.7.1.7 Connections to existing structures may require rehabilitation or reconstruction of the structure being utilized. This work will be considered part of the project being proposed.

4.7.2. Adjusting Manholes to Grade. When a project requires a manhole to be adjusted to grade a maximum of twelve (12) inches of rise is allowed if not previously adjusted. Adjustments greater than twelve (12) inches, or lowering, will generally require rebuilding all or part of the manhole.

4.7.3. Swimming Pools. Swimming pool backwash connections to the sanitary sewer must not exceed fifty gallons per minute (50 gpm).

4.7.4. Channel Crossings. When a sanitary sewer crosses under a channel, ductile iron pipe with restrained joints in concrete encasement must be used. The intrados of the pipe shall be a minimum of two (2) feet below the bed of the stream. A manhole shall be provided on both sides of the crossing at changes of pipe materials at a minimum distance of ten (10) feet from top of bank of both sides of the crossing.

4.7.5. Private Force Main Connections. When site topography does not allow for gravity lateral service to the sanitary sewer, a private force main connection may be made. The Department requires that a grinder pump or sewage ejector be used in these cases.

4.7.6. Storm Sewers Crossing Over Sanitary Sewers. When a storm pipe crosses over a sanitary sewer and the vertical clearance is less than two (2) feet, the sanitary sewer

4. WASTEWATER

must be encased in concrete through the crossing and for ten (10) lineal feet each side of the crossing.

4.7.7. Location in Conjunction With Water Service. Sanitary sewers shall be at least ten (10) feet horizontally from any existing or proposed water main. On crossings, a minimum vertical clearance of eighteen (18) inches shall be provided between the outside of the water main and outside of the sanitary sewer. See Design Detail WS.04.

4.7.8. Sanitary Sampling "T". A sanitary sampling "T" is required for non-residential, commercial, and industrial projects. The "T" must be six (6) inches in diameter and be located in the private building lateral as directed by the Department of Public Works.

4.7.9. Abandonment of Sanitary Sewer Services. Sanitary sewer laterals, from buildings to be demolished, shall be plugged with concrete unless the lateral is to be used for the replacement building. The lateral shall be plugged with concrete at the foundation wall or at the last trap leaving the building.

4.7.10. Oil/Water Separators and Sand Filters

4.7.10.1 If required by the Department, grease, oil and sand interceptors or traps shall be provided when such devices are necessary for the proper handling of liquid wastes containing grease or oil in excessive amounts or any flammable wastes, sand, or other harmful materials which can be trapped. Such interceptors or traps shall not be required for private dwelling units. Prior to the installation of any interceptor or trap, drawings and specifications shall be submitted to the Department for approval. All interceptors and traps shall be located so as to be readily accessible for cleaning and inspection.

4.7.10.2 Grease and oil interceptors or traps shall be constructed of impervious materials capable of withstanding sudden and extreme changes in temperature. All such devices shall be of substantial construction, water-tight, and equipped with easily removable covers which, when bolted in place, shall be gas tight and watertight.

4.7.10.3 All grease, oil and sand interceptors or traps shall be maintained in effective operation at all times by and at the expense of the user.

4.7.11. Sanitary Detention Requirements. When it has been determined that the outfall sewer or the downstream system serving a proposed development is overcharged, the Department may require the developer to provide special facilities that the Department deems necessary, for example, a sanitary holding tank (detention) for eighteen (18) hours of storage, with discharge during the off-peak hours or upgrading the downstream system to provide additional capacity. In the design of such facilities, consideration should be given to the protection of structures and equipment against corrosive and/or explosive gasses that may result from the detention of sewage.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

4.8. FIELD PERFORMANCE AND ACCEPTANCE TESTS. All sewage collection system lines shall be tested upon completion of installation. The engineer will designate on the plans the locations of the test and extent of the system to be tested, optional methods of testing alignment, and the extent of recording test results. Sections of the system which fail to pass the tests shall have defects located and repaired or replaced and be re-tested until within the specified allowance.

4.8.1. Ball Test for Gravity Lines. Prior to other tests, all lines shall be tested for cleanliness and major defects by flushing with an appropriately sized sewer cleaning ball. Pre-cleaning by high velocity jet or other method may be necessary.

4.8.2. Visual Test for Gravity Lines. All lines shall be inspected visually to verify accuracy of alignment and freedom from debris and obstructions. The full diameter of the pipe for straight alignments shall be visible when viewed between consecutive cleanouts or manholes. The method of test shall be either photography, closed circuit television, or visually lamping with mirrors and lights.

4.8.3. Leakage Tests for Force Mains

4.8.3.1 General. To prevent pipe movement, sufficient backfill shall be placed prior to filling the pipe with water and field testing. When local conditions require that the trenches be backfilled immediately after the pipe has been laid, the testing may be carried out after backfilling has been completed but before placement of permanent surfacing. The Developer/Contractor shall ensure that thrust blocking or other types of restraining systems will provide adequate restraint prior to pressurizing the pipeline.

4.8.3.2 Cross-connection control. When existing water mains are used to supply test water, they should be protected from backflow contamination by temporarily installing a double check-valve assembly between the test and supply main or by other means approved by the Department. Prior to pressure and leakage testing, the temporary backflow protection should be removed and the main under test isolated from the supply main.

4.8.3.3 Procedure. The following procedure is based on the assumption that the pressure and leakage tests will be performed at the same time. Separate tests may be made if desired. If separate tests are made, the pressure test shall be performed first. Tests shall be performed only after the pipeline has been properly filled, flushed, and purged of all air. The specified test pressure shall be applied by means of an approved pumping assembly connected to the pipe in a manner satisfactory to the Department. The test pressure shall not exceed pipe or thrust-restraint design pressures. If necessary, the test pressure shall be maintained by additional pumping for the specified time during which the system and all exposed pipe, fittings, valves and hydrants shall be carefully examined for leakage. All visible leaks shall be stopped. All defective elements shall be repaired or removed and replaced and the test repeated until the allowable leakage requirements have been met.

4.8.3.4 Pressure test. During testing, joints and service connections shall remain exposed to facilitate locating and repairing leaks, unless initial test results indicate to the engineer that the quality of workmanship and materials used throughout will justify his approval to complete the backfill before testing. The specified pressure for the pressure test shall be applied by means of a pump and gauge which is approved by the engineer. Test pressure of 150 psi shall be maintained with ± 5 psi variance for a 2 hour test duration during which time the system and all exposed pipe, connections, fittings, valves, and hydrants shall be carefully examined for leakage. Any defective elements shall be repaired or removed and replaced and the test repeated until all visible leaks have been stopped and the allowable leakage requirements have been met.

4.8.3.5 Leakage test. The Developer/Contractor shall furnish the necessary approved gauges, pump, measuring devices, taps, piping connections, and assistance to the engineer to perform the leakage test. The duration of each pipeline shall be subjected to 150 psi unless otherwise specified. Leakage shall be defined as the quantity of water that must be supplied in the newly laid pipe, or any valved section thereof, to maintain a pressure within 5 psi of the specified leakage-test pressure after the pipe has been filled with water and the air in the pipeline expelled. No installation will be accepted if the leakage is greater than that determined by the following formula.

$$L = \frac{N \cdot D \cdot \sqrt{P}}{7400}$$

Where:

- L = Allowable leakage, gallons per hour (gph)
- N = Number of joints in the length of pipeline tested
- D = Nominal diameter of the pipe, inches
- P = Average test pressure during the leakage test, psi gauge

This page is intentionally blank

SECTION 5
STORMWATER

5.1. GENERAL. Stormwater sewers or channels provide the means of removing and transporting surface runoff produced from rainfall. Design requirements differ from those for either sanitary or combined sewers. This section gives the minimum technical design requirements for storm drainage facilities in the City of Pacific. In general, the formulae presented herein for hydraulic design represent acceptable procedures not necessarily to the exclusion of other sound and technically supportive formulae. Any departure from these design requirements should be discussed before submission of plans for approval and should be justified. All construction details pertaining to storm sewer improvements shall be prepared in accordance with the Design Details of the City of Pacific where applicable.

5.2. STORMWATER ANALYSIS

5.2.1 Methods of Analysis

5.2.1.1 Many good methods of modeling and calculating stormwater flow have been developed in recent years. Many are computerized and relatively easy to use. Some are very comprehensive covering everything from overall terrain modeling to flow in individual channels while others only cover a discrete segment such as flow in culvert pipes. Some are linked with CAD programs so that design and analysis are integrated. Because all require input peculiar to the watershed being analyzed and all rely on assumptions made by the analyst, it is vital that they be used by persons familiar with the field of stormwater analysis to assure reliable results.

5.2.1.2 Some of the methods in use today have been created by the private sector and software can be purchased from the developer. Some have been developed by Government agencies, are in the public domain and are available at no cost or for a nominal fee. A list of some of the more common techniques follows. This list is certainly not comprehensive as there are too many good routines available on the market today to list in this publication:

- a.) "Urban Hydrology for Small Watersheds , Technical Release No. 55 (TR55), Soil Conservation Service (SCS), U.S. Department of Agriculture (USDA)
- b.) "Water Surface Profiles, Users Manual, HEC-2", U.S. Army Corps of Engineers
- c.) "Hydraulic Design of Highway Culverts, HDS No. 5", U.S. Department of Transportation, Federal Highway Administration
- d.) "Computer-Aided Hydrology & Hydraulics (CAHH)", American Society of Civil Engineers (ASCE). This is a collection of computer routines including FLEXLIN for erosion control and channel stability, FLOWPROF for flow profiles in open channels, PONDOPT for designing and analyzing detention ponds, SCSHYDRO for analyzing and routing flow through a watershed.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

e.) "HydroCAD", Applied Microcomputer Systems

f.) Various programs by Haestad Methods, Inc.

5.2.1.3 In lieu of the above, stormwater can be calculated by the Rational Method, the procedure for which is outlined below.

5.2.2. Engineering Report Required. A stormwater analysis, prepared by an Engineer licensed to practice in the State of Missouri, shall be prepared for each development project in the City of Pacific. This report shall describe the techniques used and assumptions made in the analysis. It shall also show:

a.) Flow from the watershed before and after development for the 2-year, 25-year and 100-year storms.

b.) Ability of all stormwater structures, channels, pipes, detention basins, control devices, etc. to handle the water flowing through them. Ability shall include ability to handle flow velocity as well as flow quantity without scouring or damage to structures or adjacent improvements.

c.) Hydraulic grade line in channels throughout the watershed for the 2-year, 25-year and 100-year storms.¹

5.2.3. Rainfall Frequency.

5.2.3.1 Stormwater flow shall be analyzed for the 2-year, 25-year and 100-year storm event. Rainfall amounts shall be the most recent values published by the National Oceanographic and Atmospheric Agency (NOAA) for Franklin County, Missouri. Present values (1999) are contained in Table 5-1.

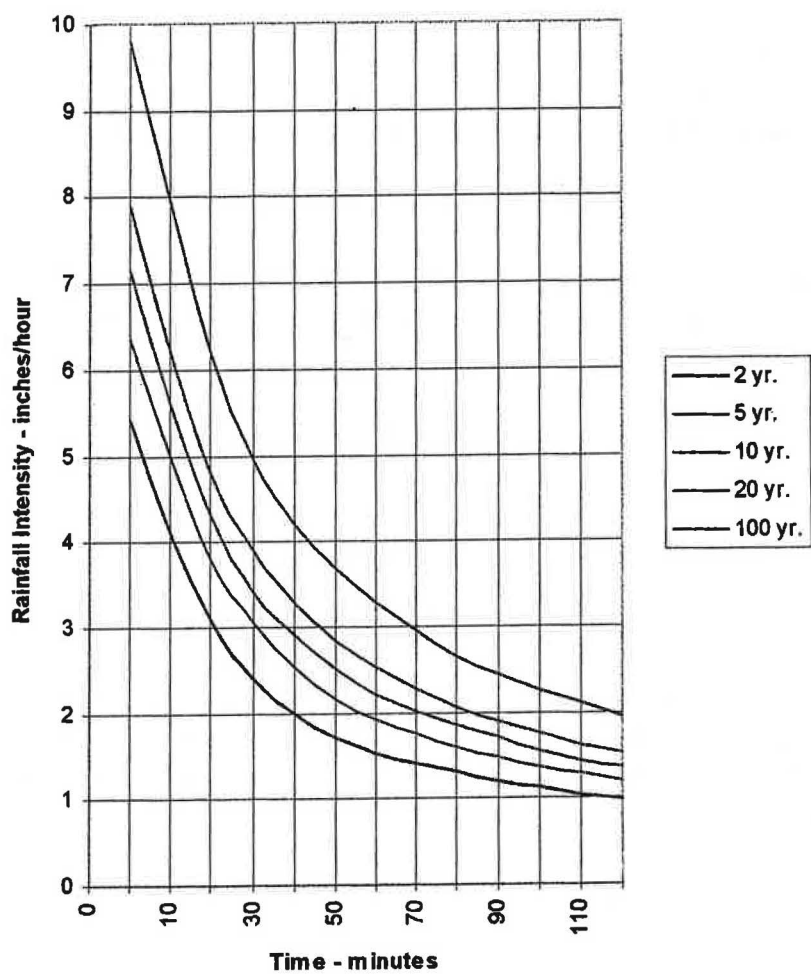
5.2.3.2 If the Rational Method is used, a one hundred (100) year rainfall frequency and a twenty (20) minute time of concentration shall be used for stormwater calculations in the City of Pacific. Figure 5-1 gives rainfall curves for 1, 2, 5, 10, 25, 50 and 100 year frequencies. Values for other frequencies can be derived by interpolation.

**Table 5-1
24-Hour Storm Events**

Frequency, years	Rainfall, inches
1	3.0
2	3.5
5	4.5
10	5.1
25	5.8
50	6.5
100	7.2

¹ Hydraulic grade line is not required for sheet flow or shallow concentrated flow over land surfaces.

Figure 5-1
Rainfall Intensity - Duration Curves



PACIFIC DESIGN & CONSTRUCTION STANDARDS

5.2.4. Rational Method.

5.2.4.1 If the Rational Method is used, flow quantities will be determined by the equation:

$$Q = API$$

Where:

Q= runoff in cubic feet per second

A= tributary area in acres.

I = Average intensity of rainfall (inches per hour) for a given period and a given frequency.

P = runoff factor based on runoff from pervious and impervious surfaces.

P (Runoff Factors) for various impervious conditions are shown in Table 5-2.

P.I. values for various impervious conditions are shown in Tables 5-3.A through 5-3.C. These tables give rainfall values for 2, 5, 10, 15, 20 and 100 year frequencies. Other values can be determined by interpolation.

5.2.4.2 Impervious Percentages and Land Use. Minimum impervious percentages to be used are as follows²:

a.) For manufacturing and industrial areas, 100%.

b.) For business and commercial areas, 100%.

c.) For residential areas, including all areas for roofs of dwellings and garages; for driveways, streets, and paved areas; for public and private sidewalks; with adequate allowance in area for expected or contingent increases in imperviousness:

1.) In apartment, condominium and multiple dwelling areas: 75%

2.) In single family areas:

1/4 Acre or less	50%
1/4 Acre to 1/2 Acre	40%
One acre or larger	30%
Playgrounds (Non- Paved)	20-35%*

² In lieu of using a composite number for the whole areas, drainage areas may be broken into component areas, with the appropriate run-off factor applied to each component, i.e., a proposed development may show 100% impervious for paved areas and 5% impervious for grassed areas.

Table 5-2
P Factor for Runoff

% Impervious	Duration of Rain - minutes					
	15	20	30	60	90	120
0	0.30	0.35	0.41	0.51	0.56	0.60
5	0.32	0.37	0.43	0.53	0.58	0.62
10	0.34	0.39	0.46	0.56	0.60	0.64
15	0.36	0.41	0.48	0.58	0.62	0.66
20	0.38	0.44	0.50	0.60	0.64	0.67
25	0.40	0.46	0.52	0.62	0.66	0.69
30	0.42	0.48	0.54	0.64	0.68	0.71
35	0.44	0.50	0.57	0.66	0.70	0.73
40	0.46	0.52	0.59	0.68	0.72	0.74
45	0.48	0.54	0.61	0.71	0.74	0.76
50	0.50	0.56	0.63	0.73	0.75	0.78
55	0.52	0.58	0.65	0.75	0.77	0.80
60	0.54	0.60	0.68	0.77	0.79	0.81
65	0.56	0.63	0.70	0.79	0.81	0.83
70	0.58	0.65	0.72	0.81	0.83	0.85
75	0.60	0.67	0.74	0.84	0.85	0.87
80	0.62	0.69	0.76	0.86	0.87	0.88
85	0.64	0.71	0.79	0.88	0.89	0.90
90	0.66	0.73	0.81	0.90	0.91	0.92
95	0.68	0.75	0.83	0.92	0.93	0.94
100	0.70	0.77	0.85	0.94	0.95	0.95

Rainfall intensity of 1 inch per hour on 1 acre = 1.008 cu. ft. per second on 1 acre
= 1 cu. ft. per second on 1 acre (approx.)

$P \times I = Q$ = Runoff in cu. ft. per sec. per acre for given % imperviousness of contributing area during a rainfall of given intensity corresponding to the given duration to the given duration and a selected frequency.

$P = \text{Runoff/Rainfall}$ = Ratio of runoff contributed by an area of given % imperviousness for a given duration period to the rainfall of a given intensity corresponding to the same duration period and a selected frequency.

I = Intensity of rainfall in inches per hour for given duration and given frequency.

Table 5-3A
P.I. Factors for Impervious Conditions
2 Year and 5 Year Rainfall Frequencies

Rain Duration, min.	% Imp*	P.I. Factor - Cubic Feet/Second/Acre											
		2-Year Rainfall Frequency						5-Year Rainfall Frequency					
		15	20	30	60	90	120	15	20	30	60	90	120
	0	1.08	1.09	1.00	0.79	0.66	0.58	1.31	1.33	1.25	1.00	0.83	0.72
	5	1.15	1.15	1.05	0.82	0.68	0.60	1.40	1.41	1.31	1.04	0.86	0.74
	10	1.22	1.21	1.11	0.86	0.70	0.61	1.48	1.48	1.38	1.09	0.89	0.76
	15	1.30	1.27	1.16	0.89	0.73	0.63	1.57	1.56	1.44	1.13	0.92	0.97
	20	1.37	1.35	1.22	0.92	0.74	0.64	1.66	1.65	1.52	1.17	0.94	0.80
	25	1.44	1.41	1.27	0.96	0.77	0.66	1.74	1.73	1.58	1.22	0.97	0.83
	30	1.51	1.47	1.32	0.99	0.79	0.68	1.83	1.81	1.64	1.25	1.00	0.85
	35	1.58	1.54	1.38	1.02	0.81	0.70	1.92	1.88	1.72	1.29	1.03	0.87
	40	1.66	1.61	1.43	1.05	0.84	0.71	2.01	1.98	1.78	1.33	1.06	0.89
	45	1.73	1.67	1.49	1.09	0.86	0.73	2.09	2.05	1.85	1.38	1.09	0.91
	50	1.80	1.74	1.54	1.12	0.88	0.74	2.18	2.13	1.92	1.42	1.11	0.93
	55	1.87	1.80	1.59	1.16	0.90	0.76	2.27	2.20	1.98	1.46	1.14	0.95
	60	1.94	1.86	1.65	1.19	0.92	0.78	2.35	2.28	2.05	1.51	1.17	0.97
	65	2.02	1.94	1.70	1.23	0.95	0.80	2.44	2.38	2.11	1.55	1.20	1.00
	70	2.09	2.00	1.76	1.26	0.97	0.81	2.53	2.45	2.19	1.59	1.23	1.01
	75	2.16	2.06	1.81	1.29	0.99	0.83	2.62	2.53	2.25	1.64	1.26	1.04
	80	2.23	2.12	1.85	1.33	1.02	0.85	2.70	2.60	2.31	1.68	1.29	1.06
	85	2.30	2.19	1.92	1.36	1.04	0.86	2.79	2.68	2.39	1.72	1.31	1.08
	90	2.38	2.26	1.96	1.40	1.06	0.88	2.88	2.77	2.45	1.76	1.34	1.10
	95	2.45	2.33	2.03	1.43	1.08	0.90	2.96	2.85	2.52	1.80	1.37	1.12
	100	2.52	2.39	2.07	1.46	1.11	0.91	3.05	2.93	2.58	1.84	1.40	1.14
	Rainfall	3.60	3.10	2.44	1.55	1.17	0.96	4.36	3.80	3.04	1.96	1.48	1.20
* % Impervious													

d.) For parks and cemeteries, 10%

5.2.5 Hydraulic Grade Line for Closed Conduits

5.2.5.1 The hydraulic grade line is a line coinciding with (a) the level of flowing water at any given point along an open channel, or (b) the level to which water would rise in a vertical tube connected to any point along a pipe or closed conduit flowing under pressure.

5.2.5.2 The hydraulic grade line shall be computed to show its elevation at all structures and junction points of flow in pipes, conduits and open channels, and shall provide for the losses and the differences in elevations as required below. Since it is based on design flow in a given size of pipe or conduit or channel, it is of importance in determining minimum sizes of pipes within narrow limits. Sizes larger than the required minimum generally provide extra capacity, however consideration must still be given to the respective pipe system losses.

5.2.5.3 There are several methods of calculating losses in storm sewer design. The following procedures are presented for the engineer's information and consideration. It is expected that the design will recognize the reality of such losses occurring and make such allowances as good engineering judgment requires.

5.2.5.4 Friction Loss. The hydraulic grade line is affected by friction loss and by velocity head transformations and losses. Friction loss is the head required to maintain the required flow in a straight alignment against frictional resistance because of pipe or channel roughness. It is determined by the equation:

$$h_f = L \times S_h$$

Where:

h_f = difference in water surface elevation, or head in feet in length L

L = length in feet of pipe or channel

S_h = hydraulic slope required for a pipe of given diameter or channel of given cross-section and for a given roughness " n ", expressed as feet of slope per foot of length.

From Manning's formula:

$$S_h = [V n / (1.486 R^{0.667})]^2$$

Where:

R = hydraulic radius of pipe, conduit or channel (feet) (Ratio of flow area/wetted perimeter)

PACIFIC DESIGN & CONSTRUCTION STANDARDS

V = velocity of flow in feet per second (fps)
n = Manning's value for coefficient of roughness

Use:

n = 0.013 for pipes of concrete, vitrified clay, and PVC
n = 0.012 for formed monolithic concrete, i.e., vertical wall channels, box culverts and for R.C.P. over 48" in diameter.
n = 0.015 for concrete lining in ditch or channel inverts and trapezoidal channels
n = 0.020 for grouted riprap lining on ditch or channel side slopes
n = 0.033 for gabion walled channels

Note:

"n" will have a weighted value for composite lined channels.

"n" values for unlined channels to be determined on an individual basis.

5. 2.5.5 Curve Loss. Curve loss in pipe flow is the additional head required to maintain the required flow because of curved alignment, and is in addition to the friction loss of an equal length of straight alignment. It should be determined from Figure 5-2.

5. 2.5.6 Entrance Loss at Terminal Inlets. Entrance loss is the additional head required to maintain the required flow because of resistance at the entrance. The entrance loss at a terminal inlet is calculated by the formula:

$$H_{ti} = (V^2/2g)$$

Where:

V = Velocity in flow of outgoing pipe
g = Acceleration of gravity (32.2 Ft/Sec/Sec)

5. 2.5.7 Turn Loss. Head losses in structures due to change in direction of flow (turns) in a structure, will be determined in accordance with Table 5-4:

Table 5-4
Loss in Turns

<u>Change in Direction of Flow (A)</u>	<u>Multiplier of Velocity Head of Water Being Turned (K)</u>
90 deg.	0.70
60 deg.	0.55
45 deg.	0.47
30 deg.	0.35
15 deg.	0.18
0 deg.	0.00
Other Angles	By Interpolation

Table 5-3B
P.I. Factors for Impervious Conditions
15 Year and 20 Year Rainfall Frequencies

Rain Duration, min.	% Imp*	P.I. Factor - Cubic Feet/Second/Acre											
		15-Year Rainfall Frequency						20-Year Rainfall Frequency					
		15	20	30	60	90	120	15	20	30	60	90	120
	0	1.59	1.61	1.52	1.22	1.04	0.92	1.65	1.68	1.60	1.29	1.08	0.96
	5	1.70	1.70	1.59	1.27	1.08	0.95	1.76	1.78	1.68	1.34	1.11	0.99
	10	1.80	1.79	1.68	1.33	1.12	0.97	1.87	1.87	1.77	1.40	1.15	1.02
	15	1.91	1.89	1.76	1.38	1.15	1.00	1.98	1.97	1.85	1.45	1.19	1.05
	20	2.01	2.00	1.85	1.43	1.18	1.03	2.09	2.09	1.95	1.50	1.22	1.07
	25	2.12	2.09	1.92	1.49	1.22	1.06	2.20	2.18	2.03	1.56	1.26	1.10
	30	2.23	2.19	2.00	1.54	1.26	1.08	2.31	2.28	2.11	1.61	1.30	1.13
	35	2.33	2.28	2.09	1.58	1.29	1.11	2.42	2.38	2.20	1.66	1.33	1.16
	40	2.44	2.39	2.16	1.63	1.33	1.13	2.53	2.50	2.28	1.71	1.37	1.18
	45	2.54	2.48	2.26	1.69	1.37	1.16	2.64	2.59	2.38	1.78	1.41	1.22
	50	2.65	2.58	2.33	1.74	1.40	1.19	2.75	2.69	2.46	1.83	1.44	1.24
	55	2.76	2.67	2.41	1.79	1.43	1.22	2.86	2.78	2.54	1.88	1.48	1.27
	60	2.86	2.76	2.50	1.85	1.47	1.24	2.97	2.88	2.63	1.94	1.52	1.30
	65	2.97	2.88	2.57	1.90	1.51	1.27	3.08	3.00	2.71	1.99	1.56	1.33
	70	3.07	2.97	2.66	1.94	1.54	1.29	3.19	3.10	2.81	2.04	1.59	1.35
	75	3.18	3.06	2.74	2.00	1.58	1.32	3.30	3.19	2.89	2.10	1.63	1.38
	80	3.29	3.15	2.81	2.05	1.62	1.35	3.41	3.29	2.96	2.15	1.67	1.41
	85	3.39	3.24	2.90	2.10	1.65	1.38	3.52	3.38	3.06	2.21	1.70	1.44
	90	3.50	3.36	2.98	2.16	1.68	1.40	3.63	3.50	3.14	2.27	1.74	1.46
	95	3.60	3.45	3.07	2.21	1.72	1.43	3.74	3.60	3.24	2.32	1.78	1.50
	100	3.71	3.54	3.15	2.26	1.76	1.45	3.85	3.70	3.32	2.37	1.81	1.52
	Rainfall	5.30	4.60	3.70	2.40	1.86	1.53	5.50	4.80	3.90	2.52	1.92	1.60
* % Impervious													

Table 5-3C
P.I. Factors for Impervious Conditions
10 Year and 100 Year Rainfall Frequencies

Rain Duration, min.	% Imp*	P.I. Factor - Cubic Feet/Second/Acre											
		10-Year Rainfall Frequency						100-Year Rainfall Frequency					
		15	20	30	60	90	120	15	20	30	60	90	120
	0	1.48	1.51	1.42	1.15	0.95	0.83	2.10	2.17	2.06	1.68	1.40	1.18
	5	1.57	1.59	1.49	1.19	0.99	0.86	2.24	2.29	2.16	1.75	1.45	1.22
	10	1.67	1.68	1.57	1.25	1.02	0.88	2.38	2.42	2.28	1.83	1.50	1.24
	15	1.77	1.76	1.64	1.29	1.05	0.90	2.52	2.54	2.38	1.90	1.55	1.28
	20	1.87	1.87	1.73	1.34	1.08	0.92	2.66	2.70	2.51	1.96	1.59	1.31
	25	1.97	1.96	1.80	1.40	1.11	0.95	2.80	2.82	2.61	2.05	1.64	1.35
	30	2.07	2.04	1.87	1.44	1.15	0.97	2.94	2.95	2.71	2.11	1.69	1.38
	35	2.16	2.13	1.95	1.49	1.18	1.00	3.08	3.07	2.84	2.18	1.74	1.42
	40	2.26	2.24	2.02	1.53	1.22	1.02	3.22	3.22	2.94	2.24	1.79	1.45
	45	2.36	2.32	2.11	1.59	1.25	1.05	3.36	3.35	3.06	2.33	1.84	1.49
	50	2.46	2.41	2.18	1.63	1.28	1.07	3.50	3.47	3.16	2.39	1.88	1.52
	55	2.56	2.49	2.25	1.68	1.31	1.10	3.64	3.60	3.26	2.46	1.93	1.56
	60	2.66	2.58	2.34	1.73	1.34	1.12	3.78	3.72	3.39	2.54	1.98	1.59
	65	2.76	2.69	2.40	1.78	1.38	1.15	3.92	3.88	3.49	2.61	2.03	1.63
	70	2.85	2.77	2.49	1.82	1.41	1.17	4.06	4.00	3.61	2.67	2.07	1.66
	75	2.95	2.86	2.56	1.88	1.44	1.19	4.20	4.12	3.71	2.76	2.13	1.70
	80	3.05	2.95	2.63	1.92	1.48	1.21	4.34	4.25	3.82	2.82	2.18	1.72
	85	3.15	3.03	2.72	1.97	1.50	1.24	4.48	4.37	3.94	2.89	2.21	1.76
	90	3.25	3.14	2.79	2.03	1.54	1.26	4.62	4.53	4.04	2.97	2.26	1.79
	95	3.35	3.23	2.87	2.07	1.57	1.29	4.76	4.65	4.17	3.04	2.31	1.83
	100	3.44	3.31	2.94	2.11	1.61	1.31	4.90	4.77	4.27	3.10	2.36	1.86
	Rainfall	4.92	4.30	3.46	2.25	1.70	1.38	7.00	6.20	5.02	3.30	2.50	1.96
* % Impervious													

Figure 5-2
Head Loss in Curved Pipe

SYMBOLS:

D = Diameter of Pipe

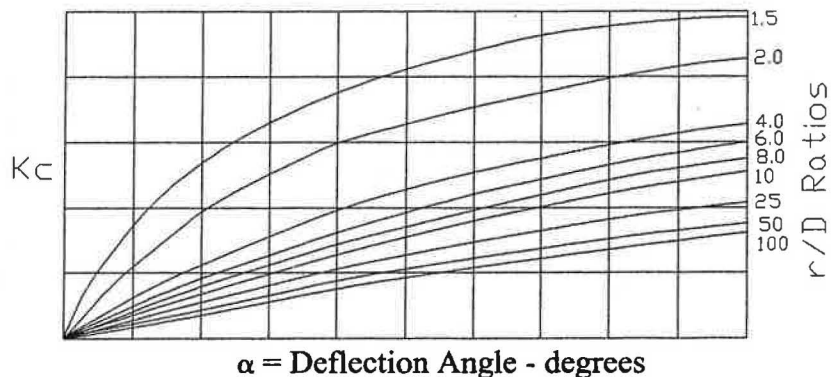
r = Radius of Curve

V = Velocity - ft./sec.

 K_C = Curve Loss Coefficient h_C = Head Loss due to curved alignment α = Deflection Angle in radiansC = Factor of conservatism to account for the variation in the experimental data for these curves. $C = 1.5$ for the design of hydraulic capacity

$$K_C = C \frac{2\alpha}{\Pi^2 \left(\ln \frac{r}{D} + \alpha \right)}$$

$$h_C = K_C \frac{V^2}{2g}$$

**EXAMPLE:**

Q = 260 cfs V = 13.2 fps D = 60 "
 $\alpha = 90^\circ$ r = 50' $V^2/2g = 2.71$
 r/D = 10

From $\alpha = 90^\circ$ on the abscissa follow a vertical line up to the intersection with the r/D = 10 curve. Then transfer on a horizontal line to the ordinate and read the corresponding curve loss coefficient.

 $K_C = 0.123$

The head loss due to curved alignment =

$$h_C = K_C \frac{V^2}{2g} = (0.123)(2.71) = 0.33$$

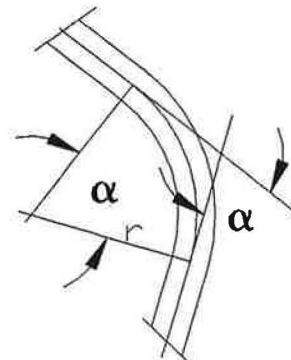
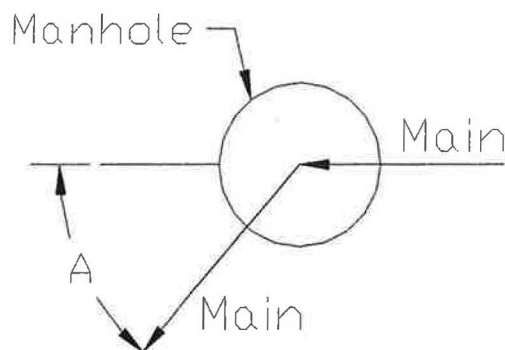


DIAGRAM:



Formula:

$$H_L = K(V_L)^2/2g$$

Where:

H_L = Feet of head lost in manhole due to change in direction of lateral flow

V_L = Velocity of flow in lateral in Ft/Sec

g = Acceleration of gravity, (32.2 Ft/Sec/Sec)

K = Multiplier of Velocity Head of water being turned

5. 2.5.8 Junction Chamber Loss. A sewer junction occurs for large pipes or conduits too large to be brought together in the usual forty two (42) inch diameter manhole or inlet where one or more branch sewers enter a main sewer. Allowances should be made for head loss due to curvature of the paths and due to impact at the converging streams. Losses in a junction chamber for combining large flows shall be minimized by setting flowline elevations so that pipe centerlines (springlines), will be approximately in the same planes. At junction points for combining large storm flows, a manhole with a slotted cover shall be provided. A computation method for determining junction chamber losses is presented below:

$$H_j = \Delta y + V_{h1} - V_{h2}$$

Where:

H_j = junction chamber loss (ft.)

V_{h1} = upstream velocity head

V_{h2} = downstream velocity head

Δy = change in hydraulic grade line through the junction in feet

Where:

$$\Delta y = \frac{[(Q_2 V_2) - (Q_1 V_1) - \{(Q_3 V_3 \cos e_3) - (Q_n V_n \cos e_n)\}]}{0.5(A_1 + A_2)g}$$

Where:

- Q_2 = Discharge in cubic feet per second (cfs) at the exiting conduit.
- V_2 = Velocity in feet per second (fps) at the exiting conduit.
- A_2 = Cross sectional area of flow in sq. ft. for the exiting conduit.
- Q_i = Discharge in cfs for the incoming pipe (main flow).
- V_1 = Velocity in fps for the incoming pipe (main flow).
- A_1 = Cross sectional area of flow in Sq. Ft. for the incoming pipe (main flow).
- Q_3, Q_n = Discharge(s) in cfs for the branch lateral(s).
- V_3, V_n = Velocity(ies) in fps for the branch lateral(s).
- q_3, q_n = The angle between the axes of the exiting pipe and the branch laterals(s).
- g = Acceleration of gravity (32.2 ft/sec/sec)

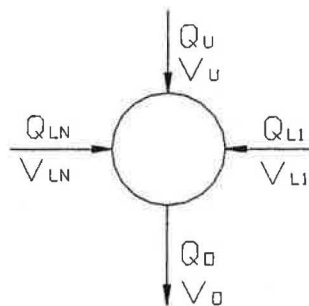
Where:

- θ = is the angle between the axes of the outfall and the incoming laterals.
- The terms within brackets [] indicate the summation of all incoming laterals (not on main sewer)

5.2.5.9 Losses at Junctions of Several Flows in Manholes and/or Inlets

5.2.5.9.1 The computation of losses in a manhole, inlet or inlet manhole with several flows entering the structure should utilize the principle of the conservation of energy. This involves both the elevation of water surface and momentum (mass times the velocity head). Thus, at a structure (manhole, inlet or inlet manhole) with laterals, the sum of the energy content for inflows is equal to the sum of the energy content of the outflows plus the additional energy required by the turbulence of the flows passing through the structure.

DIAGRAM:



5.2.5.9.2 The upstream hydraulic grade line may be calculated as follows:

$$H_u = [V_D^2/2g] - [(Q_U/Q_D)(1-K)(V_U^2/2g)] - [(Q_{L1}/Q_D)(1-K)(V_{L1}^2/2g)] \\ + [(Q_{LN}/Q_D)(1-K)(V_{LN}^2/2g)] + H_D$$

Where:

H_U	= Upstream hydraulic grade line in feet
Q_U	= Upstream main line discharge in cubic feet per second
Q_D	= Downstream main line discharge in cubic feet per second
$Q_{L1}-Q_{LN}$	= Lateral discharges in cubic feet per second
V_D	= Downstream main line velocity in feet per second
$V_{L1}-V_{LN}$	= Lateral velocities in feet per second
V_U	= Upstream main line velocity in feet per second
H_D	= Downstream hydraulic grade line in feet
K	= Multiplier of Velocity of Water being turned
g	= Acceleration of gravity, 32.2 ft/sec/sec

5.2.5.9.3 The above equation does not apply when two (2) almost equal and opposing flows, each perpendicular to the downstream pipe, meet and no other flows exist in the structure. In this case the head loss is considered as the total velocity head of the downstream discharge.

5.2.5.10 Transition Loss

5.2.5.10.1 The relative importance of the transition loss is dependent on the velocity head of the flow. If the velocity and velocity head of the flow are quite low, the transition losses cannot be very great. However, even small losses may be significant in flat terrain. The sewer design shall provide for the consideration of the necessary transitions and resulting energy losses. The possibility of objectionable deposits is to be considered in the design of transitions.

5.2.5.10.2 For design purposes it shall be assumed that the energy loss and changes in depth, velocity and invert elevation, if any, occur at the center of the transition. These changes shall be distributed throughout the length of the transition in actual detailing. The designer shall carry the energy head, piezometric head (depth in an open channel), and invert as elevations, and work from the energy grade line. Because of inherent differences in the flow, transitions for closed conduits will be considered separately from those for open channels.

5.2.5.10.3 Transitions in small sewers may be confined within a manhole. Special structures may be required for larger sewers. If a sewer is flowing

surcharged, the form and friction losses are independent of the invert slope, therefore, the transition may vary at the slopes of the adjacent conduits. The energy loss in a transition shall be expressed as a coefficient multiplied by the change in velocity head ($\Delta V^2/2g$) in which ΔV is the change in velocity before and after the transition. The coefficient may vary from zero to one, depending on the design of the transition.

5.2.5.10.4 If the areas before and after a transition are known, it is often convenient to express the transition loss in terms of the area ratios and either the velocity upstream or downstream.

a.) For an expansion:

$$H_L = K(V_1 - V_2)^2/2g$$

$$\approx [K(V_1)^2/2g] [1 - (A_1/A_2)]^2$$

Where:

H_L = the energy loss

K = a coefficient equal to 1.0 for a sudden expansion and approximately 0.2 for a well-designed transition

A_1 = Area Before Transition (the upstream section)

A_2 = Area After Transition (the downstream section)

V_1 = Velocity Before Transition (the upstream section)

V_2 = Velocity After Transition (the downstream section)

b.) For a contraction:

$$H_L = [K(V_2)^2/2g] [(1/C_c) - 1]^2$$

$$\approx [K(V_2)^2/2g] [1 - (A_2/A_1)]^2$$

Where:

K = a coefficient equal to 0.5 for a well-designed transition

C_c = a coefficient of contraction which depends on the configuration of the orifice. Appropriate values are contained in textbooks on hydraulics. Other terms are the same as in the previous equation. Losses in closed conduits of constant area are expressed in terms of $(V^2/2g)$.

5.2.5.10.5 The above equations may be applied to approximate the energy loss through a manhole for a circular pipe flowing full. If the invert is fully developed, that is, semi-circular on the bottom and vertical on the sides from one-half depth up to the top of the pipe, for the expansion $(A_1/A_2) = 0.88$, and for the contraction (A_2/A_1)

= 0.88. The expansion is sudden, therefore, $K = 1$. The contraction may be rounded if the downstream pipe has a bell or socket. In this case, K may be assumed to be 0.2.

5.2.5.10.6 The expansion energy loss is $0.014 [(V_1)^2/2g]$ and the contraction energy loss is $0.010 [(V_2)^2/2g]$. If the invert is fully developed, the manhole loss is small, but if the invert is only developed for one-half of the depth, or not at all, the losses will be of considerable magnitude.

5.2.5.10.7 Transitions to Open Channels. The hydraulics of open channel transitions are further complicated by possible changes in depth. As a first approximation to the energy loss, unless a jump occurs, the equations given above may be used with a trial-and-error solution for the unknown area and velocity. The K value for a well-designed expansion should probably be increased to 0.3 or 0.4. Whether the properties of the upstream or downstream section will be known will depend on the characteristics of the flow and the channel, but can be determined by a profile analysis. In transitions for supercritical flow, additional factors shall be considered. Standing waves of considerable magnitude will be produced in transitions. The height of these waves must be estimated to provide a proper channel depth. In addition, in long transitions, air entrainment will cause bulking of the flow with resultant greater depths of the air-water mixture.

5.2.5.11 Hydraulic Grade Line Limits. For all sewers, regardless of the method of calculation, the hydraulic grade line shall not rise above the following limits:

a.) The hydraulic grade line at any inlet shall not be higher than six (6) inches below the inlet sill. The hydraulic grade line at any storm manhole shall be no higher than one (1) foot below the top.

b.) Storm sewers shall not flow with greater than three (3) feet of head without special pipe joint requirements.

c.) The hydraulic grade line for combined sewers shall not rise above the pipe intrados.

d.) The beginning point for the hydraulic grade line computations shall be the higher elevation as determined below:

1.) For connection to existing pipe system:

(a) Top of pipe intrados of one reach downstream of the connection point of the existing system; or

(b) The hydraulic grade line computed for the existing system.

2.) For connection to channels or ditches:

- (a) Top of pipe intrados of the proposed pipe, or
- (b) The hydraulic grade line computed for the channel or ditch as approved by the Commissioner.

5.2.6 Hydraulic Grade Line for Open Channels

5.2.6.1 In open channels the water surface is identical with the hydraulic grade line. The hydraulic grade line shall be computed throughout the channel reach to show its elevation at junctions with incoming pipes or channels and at the ends of the channel reach under consideration. It shall also provide for the losses and differences in elevations as required below. Since it is based on design flow in a given channel, it is of importance in determining minimum sizes within narrow limits. The depth at which the actual flows will occur is controlled by the two end conditions of the reach considered, and by the relationship between the energy available and by the energy required to overcome the losses that are encountered along the channel.

5.2.6.2 There are several methods of calculating losses in channel design. It is required that the design recognize the reality of such losses occurring and make such allowances as good engineering judgment indicates. The following procedures are presented for the engineers information and consideration.

5.2.6.3 Control Sections. The engineer should locate all possible control sections for the reach in question. A control section refers to any section at which the depth of flow is known or can be controlled to a required stage. At the control section, flow must pass through a control depth which may be the critical depth, the normal depth or any other known depth. Three types of control sections include (a) Upstream Control Section; (b) Downstream Control Section; (c) Artificial Control Section, which occurs at a control structure, such as a weir, dam, sluice gate, roadway embankment, culvert, bridges or at the confluence with a major river or stream.

5.2.6.4 Friction Loss. The friction loss may be calculated by the same procedure as is presented in Section 5.2.2 of this chapter.

5.2.6.5 Flow in Curved Channels. The centrifugal force caused by flow around a curve produces a rise in the water surface on the outside wall and a lowering of the inner wall. This phenomenon is called superelevation. The flows tend to behave differently according to the state of flow. In subcritical flow, friction effects are of importance, whereby in supercritical flow, the formation of cross-waves is of major concern.

- a.) Curve Losses. Curve losses may be estimated from Figure 5-2 by replacing D , diameter, with b , width of channel.

b.) Superelevations. In addition to curve losses, an evaluation of superelevations should be considered and, if required, an allowance made in the top elevation of outside wall. Equations are presented below which may be used to determine the superelevation at channel bends.

1) Trapezoidal Channels:

Subcritical Flow:

$$\Delta H_w = 1.15 (V^2/2gr_c) [b+(D(Z_L+Z_R))]$$

Supercritical Flow:

$$\Delta H_w = 2.6 (V^2/2 gr_c) [b+(D(Z_L+Z_R))]$$

2) Rectangular Channels

Subcritical Flow:

$$\Delta H_w = (V^2b/2gr_c)$$

Supercritical Flow:

$$\Delta H_w = (V^2b/2gr_c).$$

Where:

ΔH_w = Change in water height above the centerline water surface elevation.

V = Average velocity of design flow in Ft/Sec

g = Acceleration of gravity (32.2 Ft/Sec/Sec)

r_c = Radius of curve on horizontal alignment in feet

b = Base width of channel in feet

D = Depth of flow in straight channel

Z_L = Left side slope (ft/ft)

Z_R = Right side slope (ft/ft)

5.2.6.6 Transitions. Transitions should be designed to accomplish the required change in cross section with as little flow disturbance as possible. The following features are to be considered in design of transition structures.

a.) Proportioning. For a well designed transition, the following rules should be used:

1) The optimum maximum angle between the channel axis and a line connecting the channel sides between the entrance and exit sections is 12.5°.

2) Sharp angles in the structure should be avoided.

b.) Losses. The energy loss in a transition consists of the friction loss and the conversion loss. The friction loss may be estimated by the Manning Formula. The conversion loss is generally expressed in terms of the change in velocity head between the entrance and exit sections of the structure.

$$H_t = K_t \Delta V_H$$

Where:

H_t = Conversion loss

K_t = Coefficient of head loss in transition

ΔV_H = Absolute change in velocity head

Average design values for K_t are presented in the Table 5-5:

**Table 5-5
Head Loss Coefficients**

Type of Transition	Contracting Section	Expanding Section
Warped	0.10	0.20
Wedge	0.20	0.50
Cylinder-quadrant	0.15	0.25
Straight Line	0.30	0.50
Square End	0.40	0.75

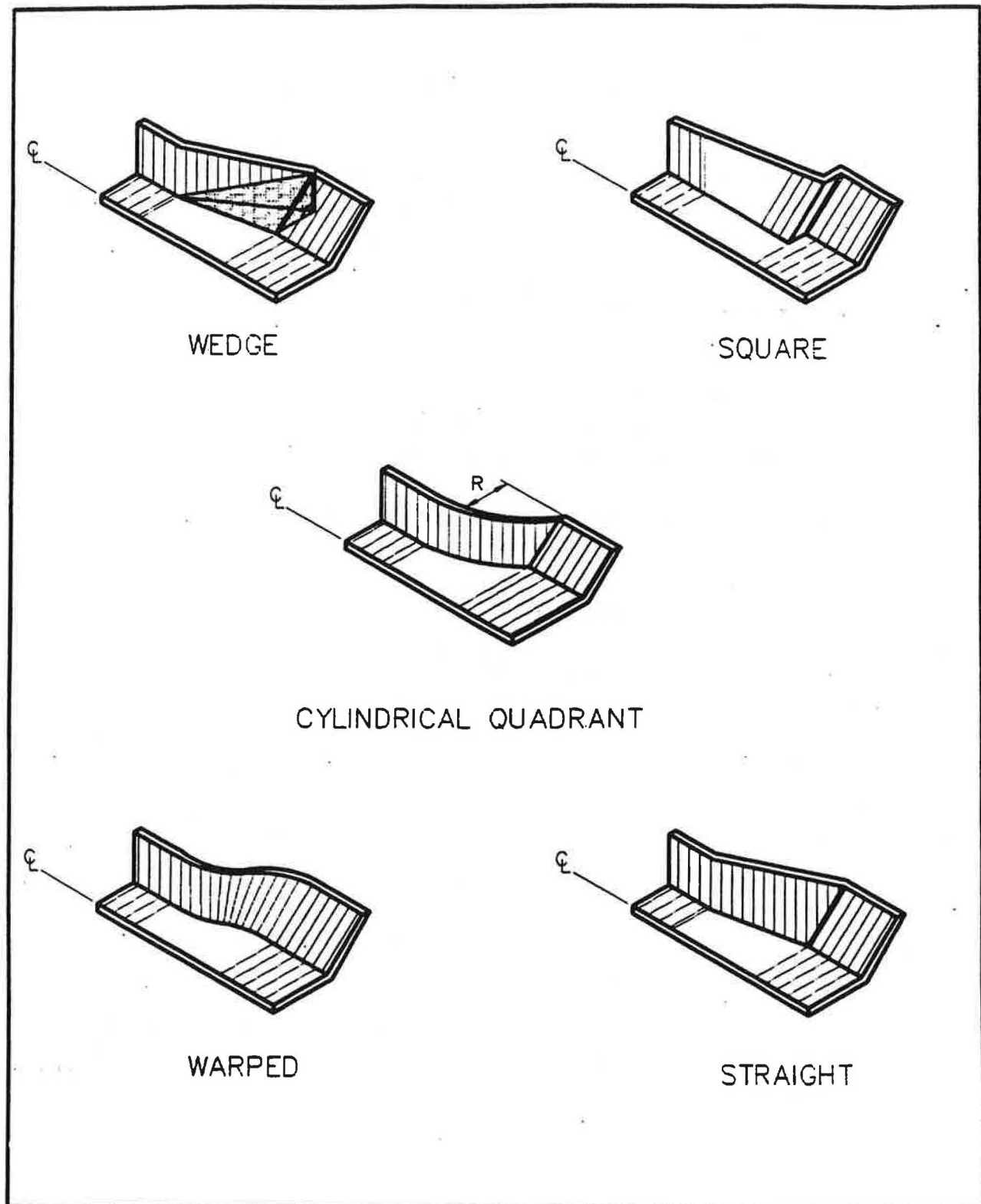
See Figure 5-3 for sketches of each type of transition.

c.) Freeboard. A transition shall have a minimum of one (1) foot of freeboard above the hydraulic grade line.

d.) Hydraulic Jump. The existence of a hydraulic jump in a transition may become objectionable, and the design of the transition should be checked for such.

e.) Sudden Enlargement and Contraction

Figure 5-3
Transition Types for Rectangular Channels



1.) A sudden enlargement results when an intense shearing action occurs between an incoming high-velocity jet and the surrounding water. As a result, much of the kinetic energy of the jet is dissipated by eddy action. The head loss at a sudden enlargement, H_{Le} is:

$$H_{Le} = K_e(\Delta V^2/2g),$$

Where:

K_e = Coefficient of head loss for enlargements = 1
 ΔV = Change in velocities between incoming and outgoing sections
 g = Acceleration of gravity (32.2 Ft/Sec/Sec)

2.) The flow in a sudden contraction is first contracted and then expanded resulting in high losses as compared to a sudden enlargement. Thus the head loss at a sudden contraction, H_{Lc} , is:

$$H_{Lc} = K_c (\Delta V^2/2g),$$

Where:

K_c = Coefficient of head loss for contractions = 0.5.
 ΔV = Change in velocities between incoming and outgoing sections.
 g = Acceleration of gravity, (32.2 Ft/Sec/Sec)

5.2.6.7 Constrictions. A constriction results in a sudden reduction in channel cross section. The effect of the constriction on the flow depends mainly on the boundary geometry, the discharge and the state of flow. When the flow is subcritical, the constriction will induce a backwater effect that extends a long distance upstream. If the flow is supercritical, the disturbance is usually local and will only affect the water adjacent to the upstream side of the constriction. A control section may or may not exist at a constriction. The control section, when it exists, may be at either side of the constriction (upstream or downstream), depending on whether the slope of the constricted channel is steep or mild. The entrance and outlet of the constriction then acts as a contraction and an expansion, respectfully.

5.2.6.8 Obstructions. An obstruction in open-channel flow creates at least two paths of flow in the channel. Typical obstructions include bridge piers, pile trestles, and trash racks. The flow through an obstruction may be subcritical or supercritical.

5.2.6.9 Hydraulic Grade Line Limits. The following limits shall apply:

a.) The hydraulic grade line at any point along a channel shall not be higher than one (1) foot below the top of the channel wall.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

b.) The hydraulic grade line at any point along a channel shall not cause the hydraulic grade limits of the storm sewer system to be exceeded.

5.2.6.10. Hydraulic Jump. When flow changes from the supercritical to subcritical state, a hydraulic jump may occur. A study should be made on the height and location of the jump, and for discharges less than the design discharge, to ensure adequate wall heights extend over the full ranges of discharge.

5.2.6.11. Open Channel Junctions

5.2.6.11.1 Consideration shall be given in the design of open channel junctions to the geometry of the confluence of flows in order to minimize undesirable hydraulic effects due to supercritical velocities.

5.2.6.11.2 The momentum equation can be applied to the confluence design if the following criteria is used.

- a.) The design water surface elevations in the two joining channels should be approximately equal at the upstream end of the confluence.
- b.) The angle of the junction intersection can vary from 0-12 degrees.
- c.) The width of the main channel shall be expanded below the junction to maintain approximate flow depths throughout the junction.
- d.) Flow depths should not exceed 90 per cent of the critical depth.

5.3. GENERAL REQUIREMENTS OF STORM SEWER CONSTRUCTION.

5.3.1. Size and Shape. The minimum diameters of pipe for stormwater sewers shall be twelve (12) inches. Sewers shall not decrease in size in the direction of the flow unless approved by the Commissioner. Circular pipe sewers are preferred for stormwater sewers, although rectangular or elliptical conduits may be used with special permission.

5.3.2. Materials. All materials shall conform to the Design Details in Section 9.

5.3.3. Bedding.

5.3.3.1 The Project Plans and Specifications shall indicate the specific type or types of bedding, cradling, or encasement required in the various parts of the storm sewer construction. Special provisions shall be made for pipes laid under or over fills or embankments in shallow or partial trenches, either by specifying extra strength pipe for the additional loads due to differential settlement, or by special construction methods to prevent or to minimize such additional loads.

5.3.3.2 If the storm and sanitary sewers are parallel and in the same trench, the upper pipe shall be placed on a shelf and the lower pipe shall be bedded in compacted granular fill to the flow line of the upper pipe.

5.3.4. Pipe or Conduit

5.3.4.1 Pipes under newly constructed streets shall be Reinforced Concrete Pipe (RCP). In other locations, polymer coated Corrugated Metal Pipe (CMP), or Corrugated High Density Polyethylene (HDPE) with smooth inside walls may be used. Pipe trenching and bedding shall be in accordance with Design Detail PIP.01, PIP.02 and/or PIP.03.

5.3.4.2 Corrugated HDPE pipe should be laid with a minimum of three (3) ft. of cover and terminated in a manhole.

5.3.4.3 Reinforced Concrete pipe shall be Class III, minimum. Joints shall be Tongue and Groove in accordance with Design Detail SW.25

5.3.4.4 Any pipe or conduit material beneath a highway, road, street, or pavement, or with reasonable probability of being so located, shall have ample strength for all vertical loads and shall provide for an AASHTO HS-20 loading. For other locations, the minimum live load shall be the HS-10 loading. Special considerations may be required for adverse conditions. Compacted granular backfill shall be utilized to the base of the pavement.

5.3.5 Monolithic Structures. Monolithic reinforced concrete structures shall be designed structurally as continuous rigid units. As much concrete as is practical shall be poured in one single operation with the reinforcing steel not terminated at the ends of a member but carried over at the joints into adjacent members.

5.3.6. Alignment

5.3.6.1 Sewer alignments are normally limited by the available easements which in turn should reflect proper alignment requirements. Since changes in alignment affect certain hydraulic losses, care in selecting possible alignments can minimize such losses and use available head to the best advantage.

5.3.6.2 Sewers shall be aligned:

a.) To be in a straight line between structures, such as manholes, inlets, inlet manholes and junction chambers, for all pipe sewers thirty (30) inches in diameter and smaller.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

b.) To be parallel with or perpendicular to the centerlines of straight streets unless otherwise unavoidable. Deviations may be made only with approval of the Department.

c.) To avoid meandering, off-setting and unnecessary angular changes.

d.) To make angular changes in alignment for sewers thirty (30) inches in diameter or smaller in a manhole located at the angle point, and for sewers thirty-three (33) inches in diameter or larger, by a uniform curve between two tangents. Curves shall have a minimum radius of ten times the pipe diameter.

e.) To avoid angular changes in direction greater than necessary and any exceeding ninety (90) degrees.

5.3.7 Location. Storm sewer locations are determined primarily by the requirements of service and purpose. It is also necessary to consider accessibility for construction and maintenance, site availability and competing uses, and effects of easements on private property. Storm sewers shall be located:

a.) To serve all property conveniently and to best advantage.

b.) In public streets, roads, alleys, rights-of-way, or in sewer easements dedicated to the City of Pacific.

c.) In easements on private property and streets only when unavoidable.

d.) On private property along property lines or immediately adjacent to public streets, avoiding diagonal crossings through the central areas of the property.

e.) At a sufficient distance from existing and proposed buildings including footings, and underground utilities or other sewers to avoid encroachments and reduce construction hazards.

f.) To avoid interference between other stormwater sewers and house connections to foulwater or sanitary sewers.

g.) In unpaved or unimproved areas whenever possible.

h.) To avoid, whenever possible, any locations known to be or probably to be beneath curbs, paving or other improvements particularly when laid parallel to centerlines.

i.) To avoid sinkhole areas if possible.

j.) Crossing perpendicular to street, unless otherwise unavoidable.

5.3.8. Flowline. The flowline of storm sewers shall meet the following requirements:

- a.) The flowline shall be straight or without gradient change between the inner walls of connected structures; that is, from manhole to manhole, manhole to junction chamber, inlet to manhole, or inlet to inlet.
- b.) Gradient changes in successive reaches normally shall be consistent and regular. Gradient designations less than the nearest 0.001 foot per foot, except under special circumstances and for larger sewers, shall be avoided.
- c.) Sewer depths shall be determined primarily by the requirements of pipe or conduit size, utility obstructions, required connections, future extensions and adequate cover.
- d.) Stormwater pipes discharging into lakes shall have the discharge flowline a minimum of three feet above the lake bottom at the discharge point or no higher than the normal water line.
- e.) A concrete cradle is required when the grade of a sewer is twenty(20) percent or greater. A special design and specification is required for grades exceeding fifty (50) percent.

5.3.9. Manholes. Manholes provide access to sewers for purposes of inspection, maintenance and repair. They also serve as junction structures for lines and as entry points for flow. Requirements of sewer maintenance determine the main characteristics of manholes. Manholes shall meet the following requirements:

- a.) For sewers thirty (30) inches in diameter or smaller, manholes shall be located at changes in direction; changes in size of pipe; changes in flowline gradient of pipes, and at junction points with sewers and inlet lines,
- b.) For sewers thirty-three (33) inches in diameter and larger, manholes shall be located on special structures at junction points with other sewers and at changes of size, alignment change and gradient. A manhole shall be located at one end of a short curve and at each end of a long curve.
- c.) Spacing of manholes shall not exceed four hundred (400) feet for pipe sewers thirty-six (36) inches in diameter and smaller; five hundred (500) feet for pipe sewers forty-two (42) inches in diameter and larger, except under special approved conditions. Spacing shall be approximately equal, whenever possible.
- d.) When large volumes of stormwater are permitted to drop into a manhole from lines twenty-one (21) inches or larger, the manhole bottom and walls below the top of such lines shall be of reinforced concrete.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

e.) Manholes shall be avoided in driveways or sidewalks.

f.) Connections to existing structures may require rehabilitation or reconstruction of the structure being utilized. This work will be considered part of the project being proposed.

5.4. OPEN CHANNELS.

5.4.1. All open channels shall meet the following requirements:

5.4.1.1 Size and Shape. Open channels shall not decrease in size in the direction of flow. Open channels shall have a regular shape (rectangular, trapezoidal, triangular) except in special cases where other approved shape is being considered.

5.4.1.2 Materials. Channels may be constructed with reinforced concrete or other approved material. However, the Department shall have the right to approve or disapprove any channel material and shall select the appropriate channel material if a proposed material is rejected. Swales shall be sodded unless velocities are excessive (greater than 5 fps), when concrete or rip-rap lined swales may be used.

5.4.1.3 Bedding. Special provisions shall be made for channels or paved swales laid over fill or non-supportive soils. Pipes extended to the channel in a fill area shall have compacted crushed limestone bedding for support.

5.4.1.4 Structural Considerations. Provision must be made for all loads on the channel.

5.4.1.5 Alignment. Open channel alignments may be limited by available easements, physical topography, existing utilities, buildings, residential development, maintenance access and roadways.

5.4.1.6 Locations. Storm channel locations are determined primarily by natural drainage conditions. It is also necessary to consider accessibility for construction and maintenance, site availability and competing uses, and evaluating effects of easements on private property. Storm channels shall be located:

- a.) To serve all adjacent property conveniently and to best advantage.
- b.) In easements or rights-of-way dedicated to the City.
- c.) In easements on common ground when feasible.
- d.) On private property along property lines or immediately adjacent to public streets, avoiding crossings through the property.

5. STORMWATER

e.) At a sufficient distance from existing and proposed buildings and underground utilities or sewers to avoid future problems of flooding or erosion.

f.) To avoid interference between stormwater sewers and house connections to foulwater or sanitary sewers.

g.) In unpaved or unimproved areas whenever possible.

h.) Crossing perpendicular to streets, unless unavoidable.

5.4.1.7 Flowline. The flowline of open channels shall meet the following requirements:

a.) Gradient changes shall be kept to a minimum and be consistent and regular.

b.) Gradient designations less than the nearest 0.001 foot per foot shall be avoided.

c.) Channel and swale depths shall be determined primarily by the requirements of the channel size, utility obstructions and any required connections.

5.4.1.8 Other Open Channel Considerations and Requirements. Channels shall meet the following additional requirements:

a.) All natural channels and ditches shall be improved unless otherwise authorized by the Commissioner.

b.) Drainage within private property should be controlled to prevent damage to the property crossed. Swales, or broad shallow grass lined ditches with non-erosive slopes, are generally located at or near rear lots and along common property lines. If a paved gutter is utilized, then appropriate erosion protection shall be used at both ends.

c.) Drainage channels and water courses draining through a subdivision shall be enclosed if the required pipe size does not exceed sixty (60) inches. When it is undesirable or impractical to enclose a channel with a pipe across a road or street, a suitable bridge or culvert shall be required.

d.) For flows greater than four (4) cfs, area inlets or inlet manholes are required to intercept the gutter or swale flow.

e.) All improved concrete channels shall have a forty eight (48) inch chain link fence on each side of the channel, or other protective measures as approved by the Commissioner.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

f.) Channels and water courses draining large areas shall be located in rights-of-way or easements previously approved by the City as a part of an adequate overall plan for drainage.

5.4.1.9 Design Limitations. The following design limitations shall apply:

a.) The flow quantity shall be calculated by the method presented in Section 5.2 or other recognized method approved by the Department.

b.) If the channel is within an area designated in the City's flood insurance study, then the channel shall also meet the City's floodplain requirements.

c.) Other agencies of jurisdiction may have requirements which must be met. An Army Corps of Engineers (COE) permit may be required for any construction affecting a watercourse. As now defined by COE, any watercourse shown as a blue line on a United States Geologic Survey (USGS) map is under their jurisdiction.

5.4.2. Erosion Protection.

5.4.2.1 Grouted rock blankets, minimum one (1) foot thick, or rock ditch liner shall be required at each end of the improved channel.

5.4.2.2 Paved ditches shall be built in accordance with Design Detail SW.22.

5.4.2.3 Rock ditch liner shall be built in accordance with Design Detail SW.23. Stone size in rock ditch liner shall be calculated using the HEC-15 routine for rip-rap.

5.4.2.4 The minimum length of the rock blanket or liner shall be twenty five (25) feet. A concrete or grouted rock toe wall, minimum two (2) foot deep, shall be constructed at the free end of each blanket or liner.

5.4.3. Sanitary Sewer Crossings. The characteristics of any sanitary sewer crossing shall be given consideration in the design of the channel floor.

5.5 INLETS

5.5.1 Inlets function entirely as entry points for stormwater flow. They also may be constructed to serve as a manhole on separate stormwater sewers, and are then termed inlet-manholes. Steep gradients may give such low inlet capacities that additional inlets should be located at more favorable grade locations or special inlets designed for steep gradients must be used. Provision must be made to control by-pass flow and to provide additional capacity

5. STORMWATER

in the inlet and line affected by such increased flow. Six (6) inch open throat inlets should be used at all times.

5.5.2 Grated inlets, without an open throat or other provision for overflow, shall be avoided except under exceptional conditions and are prohibited in grade pockets. Any exceptions shall be used only with Department approval.

5.5.3 Curb inlets shall be placed at street intersections or driveways such that no part of the inlet structure or sump is within the curb rounding.

5.5.4 Inlets and grates are shown in Standard Details SW.02 to SW.04 and SW.06 to SW.12. The minimum depth of a terminal inlet shall be four (4) feet from the top of the inlet to the flowline of the outlet pipe. Greater depth shall be used for intermediate inlets if necessary for the required depth of the hydraulic grade line. Trapped inlets shall have the depth shown in the Standard Detail SW.04.

5.5.5 Inlet capacity should not be less than the quantity flow tributary to the inlet and by-pass flow shall be avoided whenever possible.

5.5.6 Inlets at low points or grade pockets should have extra capacity to compensate for possible flow by-pass of upstream inlets. Figure 5-4 shows inlet capacity and maximum gutter capacity with a given gutter line grade and flow.

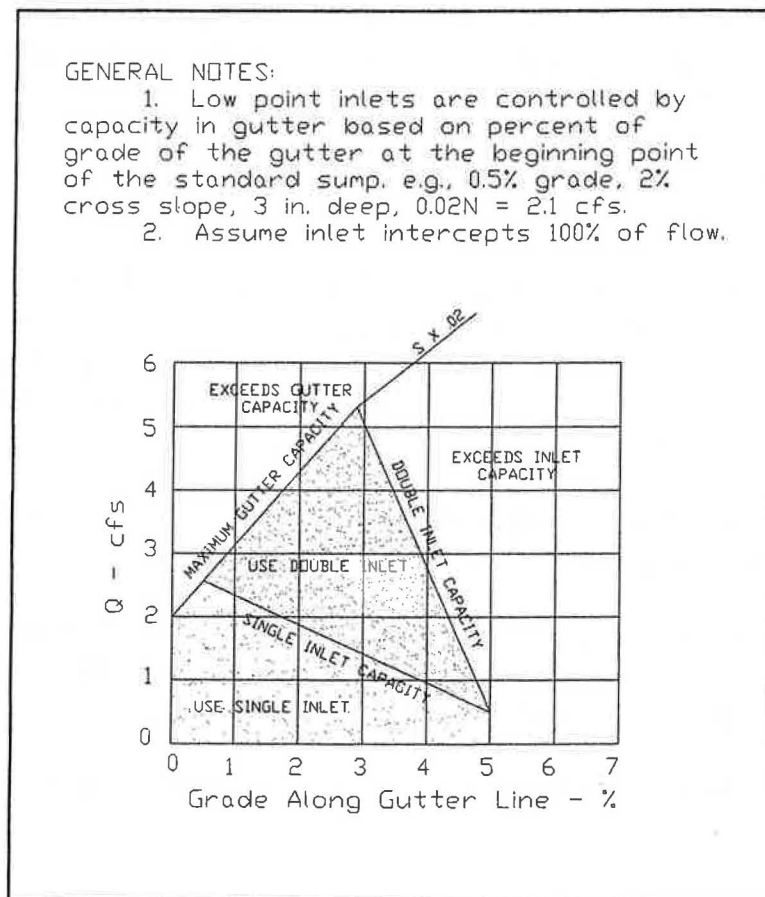
5.5.7 Street inlet sumps shall conform to the dimensions shown on Design Detail SW18, Sheets 1 through 4.

5.5.7 Connections to existing structures may require rehabilitation or reconstruction of the structure being utilized. This work will be considered part of the project being proposed.

5.6 CULVERTS

5.6.1 The design of culverts shall include consideration of many factors relating to requirements of hydrology, hydraulics, physical environment, imposed exterior loads, construction and maintenance. With the design discharge and general layout requirements determined, the design requires detailed consideration of such hydraulic factors as shape and slope of approach and exit channels, allowable head at entrance (and ponding capacity, if appreciable), tailwater levels, hydraulic and energy grade lines, and erosion potential.

Figure 5-4
Inlet and Gutter Capacity



5.6.2 Hydraulic Design. The hydraulic design of a culvert for a specified design discharge involves (1) selection of a type and size, (2) determination of the position of hydraulic control, and (3) hydraulic computations to determine whether acceptable headwater depths and outfall conditions will result. Hydraulic computations will be carried out by standard methods based on pressure, energy, momentum and loss considerations. Federal Highway Administration Report HDS No. 5, "Hydraulic Design of Highway Culverts" is recommended as a method of calculation.

5.6.3 Entrances and Outlets, Headwalls and Endwalls.

5.6.4.1 All new culverts shall be fitted with flared end sections or headwalls and endwalls at both inlet and outlet ends. Flared end sections shall conform to Design Details SW.19, SW.21 and SW.27.

5. STORMWATER

5.6.4.2 Where an existing culvert is to be extended, existing capacity is not to be degraded. The possibility for improving existing capacity should be investigated. Marked improvement may be obtainable by proper entrance design.

5.6.4.3 All culverts shall be installed with rock blankets as shown in Design Details SW.19 and SW.20.

5.6.4 Construction and Design.

5.6.4.1 Reinforced concrete pipe culverts shall be designed and installed in accordance with Design Detail SW.24 Sheets 1 and 2.

5.6.4.2 Corrugated Metal Pipe (CMP) or Corrugated High Density Polyethylene (HDPE) Pipe shall be installed in accordance with Design Details PIP.01, PIP.02 or PIP.03 as appropriate. Pipe collars used with CMP shall conform to Design Detail SW.26.

5.6.4.3 Detail design and construction of all poured-in-place box culverts shall be in accordance with MoDOT 703.XX series drawings.

5.7 BRIDGES.

5.7.1 Bridges shall be designed to meet the current criteria of the Missouri Department of Transportation (MoDOT) and, as required, the U.S. Army Corps of Engineers.

5.7.2 Waterway Capacity and Backwater Effects. Sufficient capacity will be provided to pass the runoff from the 100-year design storm.

5.7.3 Clearance. The lowest point of the bridge superstructure that is positioned transverse to stream flow shall have a (freeboard) clearance of two (2) feet above design water surface elevation for the 25 year frequency and one (1) foot for the 100 year frequency.

5.7.4 Waterway Alignment. The bridged waterway will be aligned to result in the least obstruction to stream flow, except that for natural streams consideration will be given to future realignment and improvement of the channel.

5.7.5 Erosion Protection. To preclude failure by scouring, abutment and pier footings will usually be placed either to a depth of not less than five (5) feet below the anticipated depth of scour, or on firm rock if such is encountered at a higher elevation. Large multispan structures crossing alluvial streams may require extensive pile foundations. To protect the channel, revetment on channel sides and/or bottom, consisting of concrete or grouted rock blanket should be placed in accordance with MoDOT design standards.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

5.8. OUTLET EROSION PROTECTION. If outlet velocities exceed 5 f.p.s., appropriate erosion protection must be provided. Erosion protection may be required at outlets where velocities are less than 5 f.p.s. if soil conditions warrant. For paved channels a cutoff wall with appropriate protection will be required at the terminus. The cutoff wall shall extend a minimum depth of two (2) feet into the existing ground line.

5.9. LIMITATIONS ON AREAS DRAINING ACROSS SIDEWALKS OR DRIVEWAYS. Area inlets shall be required to intercept overland flows greater than one (1) c.f.s. to prevent the flow from crossing sidewalks or curbs.

5.10 IMPERVIOUS AREAS. Any area which is to be paved, re-paved, expanded or otherwise improved, that is over 3,000 square feet in area, whether presently paved or not, shall at such time as it is to be paved, re-paved, expanded or be otherwise improved, be provided with storm water drainage facilities constructed in accordance with plans and specifications submitted to and approved by the Department.

5.11 STORM WATER DETENTION

5.11.1. When required. The requirement of stormwater detention shall be evaluated for all projects submitted to the City for review and approval and may be required, if deemed necessary. Detention facilities shall be provided and designed in accordance with the requirements of this section.

5.11.2. Projects which have a differential runoff of 2 cfs or greater for the 25-year storm frequency shall have detention. If there are known storm water problems or special conditions downstream from a project, detention will be required.

5.11.3. Design Considerations

5.11.3.1 The rates (pre-developed and post developed) of runoff are to be determined for the 2, 5, 10, 15, 25 and 100-year frequencies. The Rational Method with 20 minute rainfall intensity or other recognized methods may be used but the technology and theories on which they are based must be submitted to the Department for review. (See discussion on methods of analysis in Sect. 5.2 *Stormwater Analysis*, above.) The Commissioner will make a final determination on their acceptability.

5.11.3.2 Stormwater shall be detained on site or offsite as approved and released at the rate of an existing pre-developed site for the 2, 5, 10, 25 and 100 year events to prevent possible flooding and erosion downstream. The allowable release rate may be reduced due to downstream conditions. Note that stormwater pipes, downstream from the

5. STORMWATER

control structure, shall be sized to carry the total tributary upstream watershed. No reduction in outfall pipe size shall be permitted because of detention.

5.11.3.3 The volume of detention may be provided through permanent detention facilities such as dry basins or ponds, permanent ponds or lakes, underground storage facilities or in parking lots.

5.11.3.4 Detention basin volume will be based on routing each pre-developed runoff hydrograph through the detention facility while satisfying the appropriate allowable release rate. The routing computations shall be based on an application of the continuity principle.

5.11.3.5 Design of Underground Basins

5.11.3.5.1 Adequate access for basin maintenance and inspection shall be provided. A means of visual inspection from the ground surface of the low flow device, overflow weir, and outlet structure is necessary. Access shall also be provided to allow for cleaning of the low flow device from the ground surface.

5.11.3.5.2 The basin should have sufficient volume and spillway capacity to pass/contain the 100-year event with the low flow outlet blocked.

5.11.3.6 The Engineer must submit the following for review of a detention facility:

- a.) Elevation vs Discharge tables or curves for all frequencies.
- b.) Elevation vs Storage tables or curves for all frequencies.
- c.) Inflow calculations and data for all frequencies.
- d.) Hydraulic gradeline computations for pipes entering and leaving the basin for all frequencies.
- e.) If the embankment contains fill material a geotechnical report may be required.
- f.) Site plan showing appropriate design information
- g.) Structural calculations for the outlet control structures (if required)

5.11.3.7 All ends of pipes discharging into a dry basin or pond shall be connected with the low flow pipe or control structure by means of a paved swale. The paved swale shall be non-reinforced concrete, six (6) inches thick, with a 2% slope to the center and a minimum 0.5% longitudinal slope. Paved swales shall be a minimum of four (4) feet

PACIFIC DESIGN & CONSTRUCTION STANDARDS

wide or 1.3 times the diameter of the pipe entering the basin, whichever is greater, and be keyed to structure or channel.

5.11.3.8 Railroad tie walls cannot be used where water will be in contact with the ties.

5.11.3.9 Permanent detention ponds or lakes are to be designed to minimize fluctuating lake levels. Maximum fluctuation from the permanent pool elevation to the maximum ponding elevation shall be three (3) feet.

5.11.3.10 The maximum side slopes for dry basins or ponds, and the fluctuating area of permanent ponds or lakes shall be 3:1 (three feet horizontal, one foot vertical).

5.11.3.11 Dry basins or ponds and the fluctuating areas of permanent ponds or lakes are to be sodded and kept mowed.

5.11.3.12 Control structures and overflow structures are to be reinforced concrete.

5.11.3.13 The outflow pipe shall be sized for the developed flow rate.

5.11.3.14 In basins with concrete walls or rip-rap covered slopes, the bottoms should be paved or provisions made for mowing equipment to reach the bottom (ramps, etc.).

5.11.4 Maximum Depths

a.) The maximum depth of water in a dry detention basin or pond shall not exceed four (4) feet except by special permission of the Commissioner.

b.) Parking lots used for automobiles shall have a maximum depth of eight (8) inches of water.

c.) Parking lots used for trucks or truck trailers shall have a maximum depth of water of twelve (12) inches.

5.11.5 Limits of Maximum Ponding

a.) The limits of maximum ponding elevation shall be calculated based on a routing of the design storm assuming the low flow outlet is blocked with water ponded to the overflow structures sill.

b.) The limits of maximum ponding elevation in dry basins or ponds and permanent lakes or ponds shall not be closer than thirty (30) feet

5. STORMWATER

horizontally to any building and not less than two (2) feet vertically below the lowest sill elevation of any building.

c.) The limits of maximum ponding elevation in parking lots shall not be closer than ten (10) feet horizontally to any building and not less than one (1) foot vertically below the lowest sill elevation of any building.

d.) A minimum of two (2) feet of freeboard shall be provided from top of basins to the maximum ponding elevation.

5.11.6 Easement Required. In subdivisions, the detention basin, access roads or paths, control structures, and outfall pipes are to be located in easements dedicated to the City of Pacific.

5.11.7 Maintenance Agreement. The owner(s) of the project shall execute a maintenance agreement with the City for the detention basin or pond to insure the detention area will be kept in working order, prior to plan approval. The agreement will apply to all successors or assigns of the project owner(s). The City of Pacific will not be responsible for maintenance of detention basins or ponds.

5.11.8 Detention Basin Fencing. A four (4) foot (minimum height) approved fence shall be provided around the perimeter of any basin where the design depth of storage water will exceed four (4) feet.

5.11.9 Detention Basin Elevation. The low elevation of the detention basin shall be above the 25 year, 20-minute hydraulic elevation of the receiving channel or pipe system. The City may approve a higher elevation if discharge structure flow analysis shows that a higher tailwater is acceptable.

5.12 FLOOD PLAIN REQUIREMENTS

5.12.1 Flood Plain Study. A flood plain study will be required for:

a) Development of any type, i.e., new construction, additions to existing facilities, rehabilitation of existing facilities, or site grading on all tracts or parcels of ground located in the 100-year flood plain (either Zone "A" or that portion of Zone "B" which is the headwater of a stream) shown on the current Federal Emergency Management Agency's (FEMA) Flood Boundary and Floodway Map.

b) For development on any watercourse, not identified by FEMA, that cannot be contained by a pipe sewer 66 inches in diameter or smaller for a 100-year storm event.

5.12.2 Criteria For Preparation. The following criteria will be adhered to in preparation of a Flood Plain Study:

- a.) The flood plain study shall be prepared, signed and sealed by a Professional Engineer registered in the State of Missouri.
- b.) All assumptions shall be clearly stated in the report. The modeling process, review of existing data, necessary background, purpose, flooding potential of the existing land, existing or previous studies, existing conditions computer model input and output, proposed conditions computer model input and output, 100-year and 25-year water surface elevations and profiles shall be included in the report.
- c.) Sufficient hydraulic computations shall be submitted for review to verify the 100-year and 25-year water surface elevations with the proposed development in place. The computations should also verify that the conveyance characteristics of the water course are not restricted by the proposed development when compared with the predeveloped conditions.
- d.) All elevations shall be tied in to a FEMA or U.S.G.S. benchmark which shall be referenced and shown in the study. The study shall also show the location and elevation of a temporary or permanent benchmark(s) established on the site
- e.) The study shall determine the 100-year high water elevation through the site using the elevations obtained from the most recently published Federal Emergency Management Agency Flood Insurance Study.
- f.) The determination of a starting water surface elevation used in the hydraulic computations must be stated in the flood plain study. The downstream and upstream study limits shall be measured from the most downstream and upstream edges of the development. The hydraulic computations shall extend a minimum of 100 feet beyond the cross section where the post and predevelopment water surface elevations are coincident. There may be situations where the post and pre-development water surface elevations are not coincident. In those situations, the post development water surface elevation must be lower than the predevelopment water surface elevation. Also, the hydraulic slope and energy grades should not indicate a possible rise in water surface elevation beyond the post development water surface elevation within the 100 foot study limits. A sufficient number of cross sections should be utilized within the study limits to accurately determine the water surface elevation. The City reserves the right to extend the study limits.
- g.) If a new channel or channel realignment is proposed which would require a FEMA map amendment, the developer must submit to FEMA all information required by the current FEMA "Conditions and Criteria for Floodway Revisions." Those projects which require map revisions will not be approved until a conditional letter of map revision(CLOMR) is provided by FEMA to the developer.

h.) If the development is in an area identified as a flood plain but no discharge data exists, the Engineer shall use the following guidelines for establishing the discharge for the study:

1.) Determine the 100-year discharge value from the last known discharge as shown in the Flood Insurance Study (FIS).

2.) Determine the 100-year discharge by using the Rational Method as outlined in the Storm Drainage section of this manual or other recognized method of stormwater analysis.

3.) The 100-year Rational Method discharge shall be used until that value equals the FIS discharge determined above. The FIS value shall be utilized in the flood plain study.

i.) For flood plain areas not covered by FEMA regulations, the City will not allow any rise in the 100-year water surface elevation due to an encroachment in the flood plain.

5.12.3 Filling in Flood Plains Areas

5.12.3.1 If a tract of land, located in the flood plain, has been the subject of unauthorized fill, the flood plain study shall be based on ground conditions prior to placement of unauthorized fill.

5.12.3.2 Placement of fill shall be in accordance with FEMA, COE and DNR guidelines. In the City of Pacific, the floodway fringe may be filled without providing equivalent storage in the flood plains of the Meramec River.

5.12.3.3 No fill, roadway embankments or buildings shall be placed within areas designated as a floodway on the Flood Insurance Rate Maps without the express approval of the City of Pacific, FEMA, COE and DNR as required by State and Federal statutes.

5.12.4 Detention Basins in Flood Plains. Detention basins will be allowed in flood plain areas if all other flood plain requirements are satisfied.

5.12.5 Bridges in Flood Plains. Bridges, culverts, roadway embankments or any encroachment planned in the floodway shall not increase the 100-year water surface elevation. Bridges in flood plain areas shall be designed on a one hundred (100) year storm frequency and shall provide a minimum of one (1) foot of freeboard between the bottom of the superstructure and the 100-year water surface elevation.

5.12.6 Site Plan Requirements

PACIFIC DESIGN & CONSTRUCTION STANDARDS

5.12.6.1 The site plan shall show existing and proposed contours, existing and proposed 100-year floodway limits and existing and proposed 100-year high water elevations as a minimum. The contour interval shall be two (2) feet or less. The site plan shall also show locations of the proposed encroachment and structure(s), together with existing topography.

5.12.6.2. The site plan shall show the entire flood plain (not just the project site area) a minimum of 200 lineal feet downstream and upstream of the proposed project.

5.12.6.3 Cross section locations and alignment shall be shown on the site plan. The sections should be located perpendicular to the flow in both the channel and over banks. The sections shall be taken and plotted left to right looking downstream.

5.12.6.4 Cross sections shall show the following items:

- a.) 100-year water surface elevation.
- b.) Manning's "n" values used in analysis.
- c.) Top of bank locations.
- d.) Horizontal stationing and vertical elevations
- e.) Existing and proposed ground lines
- f.) Existing and proposed sewers
- g.) Cross section identifications as it relates to the site plan and hydraulic study.
- h.) Existing or proposed structures.
- i.) Floodway limits

5.12.6.5 Crossroad culverts in the flood plain shall be designed on a 100-year storm frequency and provide a minimum of two (2) feet of freeboard at the road shoulder line.

5.12.6.6 Basement elevations, with the exception of walkouts, must be one (1) foot above the 100-year flood elevation. Basements outside the flood plain limits may be below the 100-year flood elevation if a sanitary pump is installed in the basement with the outgoing plumbing located above the 100-year elevation.

5. STORMWATER

5.12.6.7 Structures with no basements must have the lowest elevation in the structure one (1) foot above the 100-year flood elevation. The low sill of all structures in or adjacent to the floodplain shall be a minimum of two (2) feet above the 100-year flood elevation.

5.12.6.8 Channel and overbank (flood plain) velocities should generally not increase by more than 50 percent over pre-developed conditions. Velocities in excess of five (5) feet per second (fps) in channels shall require erosion protection.

This page is intentionally blank

SECTION 6
WATER SUPPLY

6. WATER SUPPLY

6.1. GENERAL REQUIREMENTS FOR WATER SUPPLY SYSTEMS

6.1.1 This section gives the minimum technical design requirements for water supply systems in the City of Pacific, Missouri. In general, the formulas presented herein for hydraulic design represent acceptable procedures not necessarily to the exclusion of other sound and technically supportive formulae.

6.1.2 The City of Pacific operates a Public Primary Community Water System complying with the requirements of the Missouri Safe Drinking Water Law, Sections 640.100 through 640.140 of the Revised Statutes of Missouri (RSMO). These laws are promulgated in the Public Drinking Water Program administered by the Missouri Department of Natural Resources (MoDNR) of the State of Missouri and contained in the Code of State Regulations (CSR) at 10 CSR 60-1.010 through 10 CSR 60-16.030. These design standards have been approved and the City operates a supervised program of water distribution under these regulations.

6.1.3 Adherence to these standards will expedite review and approval of plans because some can be processed locally and do not require additional approval by the DNR. All construction details pertaining to water system improvements shall be prepared in accordance with the requirements of this section and the Design Details contained in Section 9, unless otherwise noted. Any departure from these design requirements should be brought to the attention of the Commissioner, discussed and justified before submission of plans for approval.

6.1.4. A system of water mains, valves, and fire hydrants connected to the water supply system of the City of Pacific shall be installed by the developer. The system shall be designed to supply water service and fire protection to all lots in the development and to ensure proper circulation to and within the system.

6.1.5. Water mains shall be sized and fire hydrants shall be located as required by the Fire Department or local fire protection district and the Commissioner of Public Works.

6.2. WATER MAIN DESIGN

6.2.1 Submittals. The design of any parts of the water supply system that are not a part of the water distribution system, i.e. water supply sources, water treatment facilities, pumping facilities (except distribution system booster pumps) and water storage, must be submitted to the Department of Public Works of the City of Pacific, Missouri and the DNR for approval. For required documentation and submittal see applicable Articles under Section 6.6. of the Specifications.

6.2.2. Hydraulic Analysis. All water mains, including those not designed to provide fire protection, shall be sized by a hydraulic analysis based on flow demands and

PACIFIC DESIGN & CONSTRUCTION STANDARDS

pressure requirements. The City of Pacific maintains a master computer model of the existing system which should be consulted and used as the basis of analysis in determining the effects of adding to or revising the existing water distribution network. Design factors for computing flow are listed in Table 6-1.

Table 6-1
Water System Design Factors - City of Pacific, Missouri

Time of Day hour	Per Capita Consumpt. gpcd	Flow Factor	Hourly Consumpt. (Avg. Day) gpch	Peak Day Mult. Factor	Hourly Consumpt. (Peak Day) gpch	Peak Hour Mult. Factor	Hourly Consumpt. (Peak Hour) gpch
0:00	150	0.499	3.12	2.0	6.24	4.0	12.47
1:00	150	0.397	2.48	2.0	4.96	4.0	9.92
2:00	150	0.306	1.91	2.0	3.83	4.0	7.65
3:00	150	0.227	1.42	2.0	2.83	4.0	5.67
4:00	150	0.198	1.24	2.0	2.48	4.0	4.96
5:00	150	0.227	1.42	2.0	2.83	4.0	5.67
6:00	150	0.374	2.34	2.0	4.68	4.0	9.35
7:00	150	1.508	9.42	2.0	18.85	4.0	37.69
8:00	150	1.848	11.55	2.0	23.10	4.0	46.20
9:00	150	1.803	11.27	2.0	22.53	4.0	45.06
10:00	150	1.496	9.35	2.0	18.71	4.0	37.41
11:00	150	1.043	6.52	2.0	13.04	4.0	26.07
12:00	150	0.839	5.24	2.0	10.49	4.0	20.97
13:00	150	0.811	5.07	2.0	10.13	4.0	20.26
14:00	150	0.862	5.38	2.0	10.77	4.0	21.54
15:00	150	0.952	5.95	2.0	11.90	4.0	23.81
16:00	150	1.088	6.80	2.0	13.60	4.0	27.21
17:00	150	1.270	7.94	2.0	15.87	4.0	31.74
18:00	150	1.530	9.57	2.0	19.13	4.0	38.26
19:00	150	1.689	10.56	2.0	21.11	4.0	42.23
20:00	150	1.701	10.63	2.0	21.26	4.0	42.51
21:00	150	1.508	9.42	2.0	18.85	4.0	37.69
22:00	150	1.134	7.09	2.0	14.17	4.0	28.34
23:00	150	0.692	4.32	2.0	8.64	4.0	17.29
Σ		24.000	150.00		300.00		600.00

6.2.2.1A hydraulic analysis of any water supply system to be built in the City of Pacific shall be prepared by an Engineer licensed in the State of Missouri and submitted to the Commissioner for approval.

6.2.2.2 Many computer techniques are available today for analyzing hydraulic systems and networks. Use of any method in general use is acceptable but the engineer should submit the details of the method used and the results of computations in report form for review by the Department.

6.2.2.3 The analysis shall show the pressure profile and flow velocity along the water line(s) for conditions of minimum, average and maximum flow. The

6. WATER SUPPLY

analysis shall demonstrate that all elements of the water main(s) are adequate to withstand pressures imposed on them and that flow quantities and velocities are acceptable.

6.2.2.4 Friction losses through water mains shall be based on the Hazen-Williams formula or other acceptable method. When the Hazen-Williams formula is used, the following values for "C" shall be used for design:

a.) unlined iron or steel - 100

B.) all other materials - 130

6.2.3. Pressure. The system shall be designed to maintain a minimum residual pressure of twenty pounds per square inch (20 psi) at ground level at all points in the distribution system and under all conditions of flow, including a 1,000 gpm fire flow occurring anywhere in the system. Normal working pressure in the distribution system should be approximately 60 psi and shall not be less than 40 psi at periods of maximum demand (except fire flow). Water mains and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

6.2.4. Diameter. The minimum size of a water main for providing fire protection and serving fire hydrants shall be six-inches in diameter. Larger mains will be required, if necessary, to allow withdrawal of the required fire flow while maintaining the minimum residual pressure specified in Article 6.2.3.

6.2.5. Fire Protection. Fire protection is to be provided and all water mains shall be designed to carry fire flows. System design shall be such that fire flows and facilities are in accordance with the recommendations of the State Insurance Services Office.

6.2.6 Siting Requirements. Water main locations are determined primarily by the requirements of service and purpose. It is also necessary to consider accessibility for construction and maintenance, site availability and competing uses, and effects of easements on private property. Water mains shall be located:

a.) To serve all property conveniently and to best advantage.

b.) In public streets, roads, alleys, rights-of-way, or in easements dedicated to the City.

c.) In easements on private property only when unavoidable.

d.) On private property along property lines or immediately adjacent to public streets, avoiding crossing through the property.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

e.) At a sufficient distance from existing and/or proposed buildings (including footings) and underground utilities and sewers to avoid encroachment and reduce construction hazards.

f.) To avoid interference between house connections to sanitary sewers and stormwater sewers.

g.) In unpaved or unimproved areas whenever possible.

h.) To avoid, whenever possible, any locations known to be or probably to be beneath curbs, paving or other improvements particularly when laid parallel to centerlines.

i.) To avoid sinkholes and creeks.

6.2.7. Dead Ends. In order to provide increased reliability of service and reduce head loss, dead ends shall be minimized by making appropriate tie-ins whenever practical. Where dead-end mains occur, they shall be provided with a fire hydrant.

6.3. WATER SUPPLY SYSTEMS MATERIALS AND CONSTRUCTION

6.3.1 General

6.3.1.1 Standards and Materials Selection. Pipes, fittings, valves and fire hydrants shall conform to the standards as defined herein. If not so specified, they shall conform to the latest standards issued by the AWWA and/or ANSI if such standards exist, and be acceptable to the Department. In the absence of such standards, materials meeting applicable commercial or industry product standards and acceptable to the Department may be selected. Special attention shall be given to selecting pipe materials which will protect against both internal and external pipe corrosion. Pipes and fittings containing more than 8% lead must not be used.

6.3.1.2 Permeation of Pipe Walls. Permeation of the water supply system by organic compounds where distribution lines are installed in areas contaminated with organic compounds shall be prevented by using:

a.) Pipe and joint materials which are not subject to permeation of organic compounds, and

b.) Non-permeable materials for all portions of the water system including water mains, service connections and hydrant leads.

6.3.1.3 Used Materials. Water mains which have been used previously can only be used with special approval of the Department. In order for their use to be

6. WATER SUPPLY

considered, the Developer must prove, by verifiable documentation, that the mains have been used only to convey potable water, that they have been restored to their original condition and that they satisfy all the requirements of these and applicable AWWA standards.

6.3.1.4 One week prior to starting work, the Developer/Contractor shall notify the Department so that operations can be coordinated and an adequate inspection schedule set up and maintained throughout the progress of the planned construction.

6.3.2 Site and Work Preparation

6.3.2.1 After the Department has been notified and the work schedule established, the Contractor shall clear the route of all trees, shrubs, and other objects or materials which may directly interfere with the construction. All utility companies and other organizations should be notified for location of their respective facilities prior to starting any work. All trees, shrubs, bushes, etc., which will not interfere with the construction shall be protected from damage.

6.3.2.2. Grading in the vicinity of the pipe trenches shall be controlled so that the surface of the ground will be properly sloped to prevent water from running into the excavated areas. Any water or other liquid wastes which accumulated in the excavated areas shall be promptly removed.

6.3.3. Trenching and Excavation

6.3.3.1 Trenches, including backfill, shall conform to the requirements of Design Details PIP.01, PIP.02 and/or PIP.03. Special provisions shall be made for pipes laid under or over fills or embankments in shallow or partial trenches either by specifying extra strength pipe for the additional loads due to differential settlement, or by special construction methods such as concrete cradles or encasement to prevent or minimize such additional loads.

6.3.3.2 Excavation shall include all route clearing, the removal of trees, shrubs, brush, vegetation, fencing, paving, and all other undesirable materials that may interfere with the progress of the work. Excavation shall be done along the lines as staked and indicated on the plans and shall be continuous without improper bends or kinks.

6.3.3.3 Trenches for all water main and appurtenances shall be excavated to a sufficient depth to obtain a minimum of 3 foot-6 inches (42 inches) of cover over the top of the pipe below the finished surface. All excavation shall be made so as to assure enough space for bedding materials providing a continuous bearing for the barrel of the pipe. Holes of sufficient size shall be excavated to permit ample room for making joints.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

6.3.3.4 Where solid rock is encountered, excavation shall be carried to a depth below the pipe bottom. The overdig shall then be filled with pipe bedding materials as shown on Design Details PIP.01, PIP.02 and/or PIP.03

6.3.4 Pipe for Water Distribution Systems

6.3.4.1 All pipe used in water distribution systems shall be either ductile iron (DI) or Polyvinyl Chloride (PVC). All fittings shall be DI. PVC fittings shall not be used.

6.3.4.2 Ductile Iron Pipe

6.3.4.2.1 All ductile iron pipe shall conform to the requirements of the latest revision of ANSI/AWWA C151/A21.51 American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water. Pipe shall be cement-mortar lined in accordance with the latest revision of ANSI/AWWA C104/A21.4 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water. Lining shall be seal coated.

6.3.4.2.2 Thickness of pipe shall be determined in accordance with the methods contained in the latest revision of ANSI/AWWA C150/A21.50 American National Standard for the Thickness Design of Ductile-Iron Pipe but in no case will a pipe with a lesser wall thickness than Class 51 be used. Calculations will be based on Type 5 trench laying conditions, the minimum configuration allowed by the City of Pacific. (See Design Details PIP.01, PIP.02 and PIP.03.)

6.3.4.2.3 DI Pipe used for distribution systems shall have either push-on joints or mechanical joints (MJ). Push-on joints are preferred. Gaskets shall conform to the latest revision of ANSI/AWWA C111/A21 AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings. MJ glands shall be DI. If, for some reason, flanged joint pipe is required, it shall be furnished in accordance with the latest revision of ANSI/AWWA C115/A21.15-94 American National Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

6.3.4.2.4 Corrosion Protection. Polyethylene encasement of DI pipe, installed in accordance with ANSI/AWWA C105/A21.5 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems, shall be used in conditions where corrosion protection may be required. Soil tests and evaluations as defined in Appendix A of AWWA C105 shall be performed when directed by the Department or when DI pipe is to be laid in those areas of the City with the following soils:¹ Twomile, Gasconade rock outcrop, Auxvasse, Raccoon or Gladden. If the

¹ As reported in *Soil Survey of Franklin County, Missouri* or *Soil Survey of St. Louis County and St. Louis City, Missouri*, U.S. Department of Agriculture, Soil Conservation Service.

evaluation results in a total score of ten (10) or greater, calculated as defined in Table A.1 of AWWA C105, then polyethylene encasement shall be applied. Polyethylene may be installed per Method A or Method B of AWWA C105. Material may be either low-density polyethylene film or high-density, cross-laminated polyethylene film.

6.3.4.3 Polyvinyl Chloride (PVC) Pipe.

6.3.4.3.1 PVC pipe, 4 inch through 12 inch nominal diameter, shall conform to the requirements of the latest revision of ANSI/AWWA C900 AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution. PVC pipe, 14 inch through 36 inch nominal diameter, shall conform to the requirements of the latest revision of ANSI/AWWA C905 AWWA Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 in. through 36 in. All PVC pipe shall provide a hydrostatic design basis (HDB) of 4,000 psi and shall be furnished with cast-iron-pipe-equivalent (CI) outside diameter (OD).

6.3.4.3.2 Thickness of pipe shall be determined in accordance with the methods contained in ANSI/AWWA C900 or ANSI/AWWA C905 as applicable². Minimum acceptable pipe wall thickness and pressure class are contained in Table 6-2. Calculations will be based on trench laying conditions in Design Details PIP.01, PIP.02 and PIP.03, the minimum configuration allowed by the City of Pacific.

**Table 6-2
Minimum PVC Pipe Classes**

Nominal OD	Press. Class	DR
4 in. - 12 in.	150	18
14 in. - 36 in.	200	21

6.3.4.4. Service Connections. Pipe for all underground use as service lines, shall be "Type K" copper pipe. All copper pipe produced for this service shall be in accordance with ASTM B 88-88 Standard Specifications for Seamless Copper Water Tube. Pipe standard sizes shall be supplied according to ASTM B43. Fittings for use with the copper pipe material shall be constructed of brass or bronze, of the joint type as required for the specific connection.

6.3.5 Pipe Installation

6.3.5.1 General

6.3.5.1.1 Laying of the pipe shall commence immediately after the excavation is started, and the Contractor shall use every possible means to keep the completed pipe installation closely behind the trenching.

². These specifications also reference *PVC Pipe*, AWWA Manual 23, and *Handbook of PVC Pipe: Design and Construction*, Uni-Bell Plastic Pipe Assoc., Dallas, Texas for methods of calculating pipe stresses and sizing pipe DR.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

6.3.5.1.2 Pipe Cutting. The cutting operation shall leave a smooth cut end at right angles to the longitudinal axis of the pipe. The exterior surface of the cut end shall be beveled, and the interior surface shall be reamed or filed free of all rough edges and protrusions. Upon completion of the cutting and trimming operation, the pipe end or ends shall be marked for "make-up" depth. Prior to insertion, the pipe shall be thoroughly cleaned of all foreign materials, including filing and cutting debris.

6.3.5.1.3 Pipe Bedding: A continuous and uniform bedding shall be provided in the trench for all buried pipe. Pipe bedding shall be as shown in Design Details PIP.01, PIP.02 and/or PIP.03.

6.3.5.1.4 Backfill Pipe backfill shall be as shown in Design Details PIP.01, PIP.02 and/or PIP.03. The materials for final backfill shall be laid in 6-inch to 8-inch lifts and compacted in place. Excavated materials may be utilized for final backfill only for water mains placed outside streets or roads, and only following the removal of all boulders, large pieces of blasted rock or broken pavement. Trenches under pavement, sidewalks, parking lots, roads and any other concrete or asphalt paved area shall be backfilled to the top with Type 2 or Type 3 aggregate.

6.3.5.1.4 Cover. All water mains shall be covered with at least 42 inches of earth or other insulation to prevent freezing. Lesser cover depth may be accepted in certain areas as approved by the Department. Backfill material shall be tamped in layers around the pipe, and to a sufficient height above the pipe that the pipe is adequately supported and protected. The warning tape for all water main shall be placed in the trench backfill as shown in Design Details PIP.01, Pip.02 and/or PIP.03.

6.3.5.1.5 Pipe Alignment. Pipe lines intended to be straight shall be laid straight. Deflections from a straight line shall not exceed the manufacturer's recommendations for joint deflections. Should the planned or specified alignment require deflections in excess of the maximum recommended for the type of pipe being installed, when using a standard pipe length within the limits of available space, then either shorter pipe sections, or additional bends shall be installed.

6.3.5.1.6 Existing Utilities. Existing utilities shall be protected during the construction period. Under all circumstances, the utility involved and the parties being affected by the disrupted service shall be notified in advance of the proposed operation. All work shall be subject to the approval and acceptance of the utility involved.

6.3.5.2 Ductile Iron (DI) Pipe Installation

6.3.5.2.1 DI pipe and fittings shall be installed in accordance with the requirements of ANSI/AWWA C600 AWWA Standard for Installation of Ductile-Iron Water Mains and their Appurtenances except that trench width may be in accordance with Design Detail PIP.01, PIP.02 and/or PIP.03.

6.3.5.2.2 Pipe bedding and backfill shall be AWWA C600 Type 5 amended as shown in Design Detail PIP.01, PIP.02 and/or PIP.03. Final backfill shall be laid in 6-inch to 8-inch lifts and compacted in place.

6.3.5.3 PVC Pipe Installation:

6.3.5.3.1 PVC pipe shall be installed in accordance with the requirements of ANSI/AWWA C605 AWWA Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water and Design Details PIP.01, PIP.02 and/or PIP.03.

6.3.5.3.2 Pipe bedding and backfill shall be AWWA C605 Type 5 amended as shown in Design Details PIP.01, PIP.02 and PIP.03. Final backfill shall be laid in 6-inch to 8-inch lifts and compacted in place. Excavated materials may be utilized for final backfill only for water mains placed outside streets or roads, and only following the removal of all boulders, large pieces of blasted rock or broken pavement. Trenches under pavement, sidewalks, parking lots, roads and any other concrete or asphalt paved area shall be backfilled to the top with Type 2 or Type 3 aggregate.

6.3.6 Joints and Fittings

6.3.6.1 Joints.

6.3.6.1.1 Pipe joints in water distribution systems shall be push-on type. For DI pipe, joints and gaskets shall conform to the latest revision of ANSI/AWWA C111/A21 AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings. For PVC pipe, gaskets and joints shall conform to ASTM F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

6.3.6.1.2 The spigot ends of all pipe, regardless of type or kind, shall be visibly and clearly marked to show the insertion length or depth required to fully "make-up" each joint. With exception of field cut pipe, all "make-up" marks shall be placed on the pipe at the factory. Field cut pipe shall be marked for pipe joint depth prior to insertion.

6.3.6.2 Fittings.

6.3.6.2.1 All fittings used in water distribution systems shall be ductile iron (DI) conforming to the latest revision of ANSI/AWWA C110/A21.10 American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids or ANSI/AWWA C153/A21.53 American National Standard for Ductile-Iron Compact Fittings, 3 in. through 24 in., and 54 in. through 64 in., for Water Service. Pressure class of fittings shall not be less than that of the pipe.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

6.3.6.2.1 Fittings used in distribution systems shall have either push-on joints or mechanical joints (MJ). Push-on joints are preferred. Gaskets shall conform to the latest revision of ANSI/AWWA C111/A21 AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings. MJ glands shall be DI. If, for some reason, flanged joint fittings are required, they shall be furnished in accordance with the latest revision of ANSI/AWWA C115/A21.15-94 American National Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

6.3.6.2.3 Fittings shall be cement-mortar lined in accordance with the latest revision of ANSI/AWWA C104/A21.4 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water. Lining shall be seal coated.

6.3.7. Valves and Valve Boxes

6.3.7.1 Service Valves

6.3.7.1.1 Sufficient valves shall be provided on water mains so that inconvenience and sanitary hazards will be minimized during repairs. Valves should be located at not more than 500 foot intervals in commercial districts and at not more than one block or 800 foot intervals in other districts.

6.3.7.1.2 Valves in water distribution systems shall be resilient-seated gate valves conforming to the latest revision of AWWA C509 AWWA Standard for Resilient-Seated Gate Valves for Water Supply Service. Valves shall have, at a minimum, the same pressure rating as the pipe and be of the non-rising stem (NRS) type. Stem seal will be by O-rings. Valve ends may be flanged, tapping valve flanged, mechanical or push-on as required.

6.3.7.1.3 Valves will be of the resilient wedge type and manufactured by the American Flow Control Co., Birmingham, Alabama 35202; the Kennedy Valve Co., Elmira, New York 14902; or the Mueller Co., Decatur, Illinois 62525. Acceptable valve models are listed in Table 6-3.

**Table 6-3
Acceptable Gate Valve Models**

Manufacturer	Valve Series
American Flow Control Co.	2500
Kennedy Valve Co.	Kenseal II
Mueller Co.	2360

6.3.7.2 Air Relief Valves

6.3.7.2.1 At high points in water mains where there is a likelihood that air can accumulate, provisions shall be made to remove the air by means of hydrants or air relief valves. Valves shall be located at all high points in the system. A high point shall be considered as a peak in any pipe section which slopes up to the hydraulic grade line.

6. WATER SUPPLY

6.3.7.2.2 Automatic air relief valves shall not be used in situations where flooding of the chamber in which they are set may occur.

6.3.7.2.3 All valves shall satisfy the requirements of ANSI/AWWA C512 AWWA Standard for Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service. Valve bodies and covers shall be DI and valve connections shall be flanged.

6.3.7.2.4 Air relief valves shall be one of the following types depending on system requirements:

a.) Air Release Valves to automatically release accumulated small pockets of air.

b.) Air/Vacuum Valves, if required to automatically exhaust or admit large volume of air, shall be located at strategic points required in the system. These valves come into use when water lines are being filled (air release) or when they are being drained (vacuum release).

c.) Combination Air Valves if the operating features of both air release valves and air/vacuum valves are required.

6.3.7.2.5 Air Relief Valve Piping. The open end of an air relief pipe from automatic valves shall be extended to at least one foot above grade and provided with a screened, downward-facing elbow. The pipe from a manually operated valve should be extended to the top of the chamber in which they are placed.

6.3.7.3 Valve Boxes and Valve Vaults.

6.3.7.3.1 All valves, meters and blow-offs shall be placed in chambers of cast iron, concrete or fiberglass. Chambers shall be capable of carrying load imposed on them, including traffic loads. Traffic loads shall be appropriate for the class of street in which the chamber is placed, but in no case shall they be less than H-10 loading. All valve boxes, vaults or manholes shall have a cast iron rim and lid. The lids of all boxes, vaults or manholes shall be permanently marked with raised, cast-in letters. Nomenclature shall be appropriate to the use, e.g. "WATER", "WATER VALVE", "WATER METER", etc.

6.3.7.3.2 Valve vaults and/or manholes shall be set on a minimum 4 inch thick bed of Type 3 or Type 4 aggregate so that water will drain from the chamber. Water lines shall maintain the minimum 42 inch depth below ground line when passing through the chamber.

6.3.7.3.3 Chambers, valve vaults, pits, or manholes containing valves, blow-offs, meters or other such appurtenances to a distribution system, shall not

PACIFIC DESIGN & CONSTRUCTION STANDARDS

be connected directly to any storm drain or sanitary sewer, nor shall blow-offs or air relief valves be connected directly to any sewer. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits underground.

6.3.8. Fire and Flushing Hydrants

6.3.8.1 Location and Spacing. Hydrants shall be provided at each street intersection and at intermediate points between intersections as recommended by the State Insurance Services Office. Generally, hydrant spacing may range from 350 feet up to a maximum of 600 feet depending on the area being served. Hydrants should be located 2'-6" from the back of curb as shown on Design Detail WS.02, Fire Hydrant Setting.

6.3.8.2 Type. Fire hydrants shall be of the dry-barrel type conforming to the latest revision of ANSI/AWWA C502 AWWA Standard for Dry-Barrel Fire Hydrants. Hydrants shall be Class A or better, having a flow capacity of 1,000 gpm or greater. The hydrant shall be fitted with a 5 ¼ inch compression-type main (bottom) valve. The barrel shall be equipped with one 4 ½ inch pumper nozzle and two 2 ½ hose nozzles. A drain outlet is required. The bottom shoe shall be flanged for a mechanical joint and a swivel anchor coupling is required. (See Fire Hydrant Setting, Design Detail WS.02). Fire hydrants shall be one of the following:

- a.) American Flow Control American-Darling, Model B-62-B;
- b.) Kennedy Guardian, Model K81D, or;
- c.) Mueller Super Centurion 250, Model A-423.

6.3.8.3 A resilient wedge gate valve conforming to AWWA C509 shall be installed as a shutoff valve. This valve shall be installed in a cast iron valve box located 5 feet from the fire hydrant as shown on Design Detail WS.02, Fire Hydrant Setting.

6.3.8.4 Hydrant leads shall be Ductile Iron Pipe having a minimum diameter of 6 inches. All fittings shall be as defined in Article 6.3.5 above. The installation shall be as shown in Fire Hydrant Setting, Design Detail WS.02. If the hydrant lead is connected to an existing water main, a tapping sleeve and valve as manufactured by the Mueller Co. shall be used, or approved equal. If connected to a water main not yet constructed, the lead should be tied to a DI tee in the water main.

6.3.8.5 Hydrants shall drain into a gravel-filled sump. See Design Detail WS.02, Fire Hydrant Setting.

6.3.8.6 Flushing Hydrants or Blow-offs

6.3.8.6.1 Flushing hydrants or blow-off valves shall be placed at all piping low points in order that the system can be drained and cleaned. Valves shall be

6. WATER SUPPLY

of the hidden (buried) type and placed in lockable cast iron meter boxes. Hydrants shall be self-draining, non-freezing, compression type. Piping from the main shall be 2 inch diameter (minimum) DI pipe. Outlet shall be fitted with a 2-1/2" National Standard hose nozzle. Installation shall conform to Standard Detail WS.08. **NOTE: These hydrants are not fire hydrants.**

6.3.8.6.2 Flushing hydrants or blow-off valves shall be selected from one of the following:

- a.) Mueller Fabricated Hidden Type Flushing Hydrant;
- b.) Eclipse No. 78 Blow-Off Hydrant or Flushing Hydrant, Kupferle Foundry Co., St. Louis, MO;
- c.) Eclipse No. 85 Blow-Off Hydrant or Flushing Hydrant, Kupferle Foundry Co., St. Louis, MO.

6.3.8.6.3 A fire hydrant located at the low point in the line may be substituted for a flushing hydrant or blow-off valve. See Design Detail WS.02 for installation details.

6.3.9. Water Main Warning Tape

6.3.9.1 Water main warning tape shall be installed with all water main. Material used shall be three (3) inch wide tape made of bonded layer plastic with a metallic foil core as manufactured by the Safety Products Company, or approved equal. The metallic tape shall be coded color blue to contrast with the soil and shall bear an imprint identifying the line below, such as; **"Caution, Water Main Buried Below"**.

6.3.9.2 Tape shall be installed in accordance with the manufacturer's recommendations directly above the water main locations as the trench backfill progresses, to permit an earth cover of 12 to 18 inches over the tape. Tape splices shall be folded and taped with a moisture-proof adhesive material to insure foil contact. The material shall then be knotted to prevent tensile pressure on the splice. The tape is to be placed in a manner such that trench backfill settlement will not place an excessive tensile stress on the material. Tape splices, due to cut segments or roll termination, shall be folded and taped to maintain metallic contact and current conductivity.

6.3.10. Water Main Locator Wire

6.3.10.1 Water main locator wire shall be installed with all water main, fittings, and valve installations. The material to be installed for this purpose shall consist of a single THWN #12 U.L. approved copper wire of the solid or strand type with insulation for 600 volts. This is standard electric service wire. Insulated wire for this

PACIFIC DESIGN & CONSTRUCTION STANDARDS

service shall be provided in standard rolls of not less than five hundred (500) foot lengths.

6.3.10.2 Splices. The connector opening shall be sealed using a liquid plastic sealant to prevent moisture entrance. After splicing and sealing the connection, the splice location shall be loosely knotted to prevent stress on the connector joint.

6.3.10.3 Water main locator wire shall be placed in the trench with the water main. Where required, the wire shall be spliced using standard plastic or rubber wire connectors. The wire shall be loosely knotted at each splice location to prevent direct stress on the connection. The wire shall be laid slack in the trench so it will not be subject to tensile stress as the trench is being backfilled.

6.3.11 Thrust Blocking

6.3.11.1 Thrust Blocking. All water main and connection installations shall be thrust blocked for bends of $22\frac{1}{2}^{\circ}$ or more. All bends, tees, crosses, valves, plugs, tapping sleeves, and fire hydrants shall be provided with reaction blocking, tie rods, or joints designed to prevent movement in accordance with the schedule and details as shown in Design Detail WS.07. Bearing areas as shown, are determined on the basis of bearing against solid undisturbed earth. Thrust blocking shall be sized using the anchorage design criteria contained in Design Detail WS.05. Pre-cast concrete blocks shall not be used for thrust blocking.

6.3.11.2 Concrete to be used for thrust blocking the various bends, tees, valves, fire hydrants, etc., shall have a 3,000 psi. (minimum) compressive strength at 28 days curing time. The mix shall be as "dry" as possible using only sufficient water to permit mixing and placement. Excessive water will not be permitted.

6.3.11.3 Cement for use shall be the "high early" type to provide initial set as soon as possible. Concrete may be placed and covered with earth fill to prevent freezing during periods of cold weather. However, frozen ingredients will not be permitted for use. All accessible form materials shall be removed from the trench prior to backfill.

6.3.11.4 Before concrete placement, all connections, bolts, glands, flanges etc. shall be protected from concrete utilizing 10 mil polyethylene film. The trench wall to be used as bearing area shall be prepared as to assure that the concrete block will rest on undisturbed earth.

6.3.11.5 All concrete used and placed for this purpose shall be given at least three (3) days curing time before being placed under stress.

6.3.12 Pipe Encasement

6. WATER SUPPLY

6.3.12.1 Concrete for pipe encasement shall be of similar mix and design to that used for thrust blocking, 6.3.10 above. Placement of the concrete shall be performed in such a manner so as to insure provision of a bed or cradle under the entire pipe length.

6.3.12.2 Where joints are to be encased, the piping shall be tested prior to concrete placement to maintain a pressure 50 percent greater than normal working pressure for a period of 4 hours. All necessary precautions shall be taken to prevent flotation of the piping during or following placement of the encasement materials.

6.3.12.3 All joint and fitting bolts shall remain accessible, and shall be protected using 10 mil polyethylene film.

6.3.13 Connections to Present System

6.3.13.1 Under all circumstances, extreme care must be exercised when connecting to the present system. Foreign materials, of whatever nature, must not be permitted to enter the system. All direct connection fittings and valves shall be thoroughly rinsed or washed with a chlorine solution just prior to installation and connection. Installation, testing and sterilization of all items shall be in strict accordance with these specifications.

6.3.13.2 Where system segment shut-down is required, the actual shut-down is not to be done until all connection materials, equipment, and personnel are at the site, and the existing system point of connection has been exposed, thoroughly cleaned, and prepared for immediate installation of the connection materials. All connections are then to be made in an efficient manner requiring the least amount of time and maximum amount of care.

6.3.14. Crossing Railroads, City Streets or State/County Highways

6.3.14.1 General: All work to be performed within the right-of-way limits of Railroads, City Streets or State/County Highways shall be performed in strict accordance with the Railroad, City and/or Highway Department requirements. The Developer/Contractor shall obtain the necessary permits for all work prior to starting any construction. All permits must be displayed as detailed.

6.3.14.2 All crossings under Railroads, State/Federal Highways or City Streets shall be made through pipe encasement tubing. The Developer/Contractor will be held responsible for any and all expense incurred by the Railroad, City of Pacific or the Highway Department in protecting the roadway while construction is in progress, or as a result of said construction. The Developer/Contractor will also be held responsible for all damages to the railway, street or highway due to his operations during construction of the crossings including replacement of damaged pavement.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

6.3.14.3 The crossing shall be machine bored with simultaneous installation of the encasement. All water main for use at the crossing shall be placed in or through an encasement tube consisting of over-sized steel pipe. The encasement tube inside diameter shall be sized to allow the water main pipe with casing spacers to be placed through the tube. Materials to be used for this purpose shall consist of new steel pipe in not less than ten (10) foot lengths. The materials used for the encasement tube construction shall have a minimum yield strength of 35,000 psi. All joint ends shall be cut at 90 degrees to the longitudinal axis of the pipe. Each end shall be beveled and joints shall be butt welded around the entire perimeter of the pipe. The encasement tube shall have a minimum wall thickness of 0.250 inches.

6.3.14.4 Following completion of the encasement installation, the water main shall be installed through the encasement tube. The locator wire shall be installed through the encasement with the water main. The water pipe shall then be connected on each side of the crossing to the water distribution system, as shown on the plans.

6.3.14.5 Non-metallic casing spacers shall be utilized with all water mains installed inside encasement tubes. Casing spacers shall be plastic except that in areas contaminated with organic compounds specially treated wood spacers may be used. The spacers shall be sized to permit clearance between bell joints, flanges, couplings and other joints and the encasement wall. The casing spacers shall be equally set at intervals along the pipe, with double spacers attached at each joint. The number of spacers to be used with each water main diameter shall be according to manufacturer's specifications.

6.3.14.6 Each end of the encasement tube shall be secured with a water tight seal between the casing and the water main.

6.3.15 Separation of Water Mains, Sanitary Sewers and Storm Sewers.

6.3.15.1 General. The following factors should be considered in providing adequate separation:

- a.) materials and type of joints for water and sewer pipes,
- b.) soil conditions,
- c.) service and branch connections into the water main and sewer line,
- d.) compensating variations in the horizontal and vertical separations,
- e.) space for repair and alterations of water and sewer pipes,
- f.) off-setting of pipes around manholes.

6.3.15.2 Parallel installation. Water mains shall be laid at least 10 feet horizontally from any existing or proposed sewer. The distance shall be measured edge to edge of pipes. In cases where it is not practical to maintain a ten foot separation, the Commissioner may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a

6. WATER SUPPLY

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 in either case, at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.

6.3.15.3 Crossings. 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.

6.3.15.4 Force Mains. There shall be at least a 10-foot horizontal separation between water mains and sanitary sewer force mains. There shall be an 18-inch vertical separation at crossings as required in Article 6.4.6. Paragraph K iii.)

6.3.15.5 Sewer Manholes. No waterline shall be located closer than 10 feet to any part of a sewer manhole.

6.3.15.6 Exception. The Commissioner must specifically approve any variance from the requirements of this Article 6.e.15 when it is impossible to obtain the specified separation distances.

6.3.16 Surface Water Crossings

6.3.16.1 Surface water crossings, whether over or under water, present special problems. The Commissioner should be consulted before plans are prepared. Positive joints shall be required in pipes placed in waterways and wet weather streams.

6.3.16.2 Above-water crossings. The pipe shall be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement.

6.3.16.3 Underwater crossings. A minimum cover of four (4) feet shall be provided over the pipe. When crossing water courses which are greater than 15 feet in width, the following shall be considered:

a.) The pipe shall be of special construction, having flexible watertight joints.

b.) Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair. The valves shall be easily accessible, and not subject to flooding, and the valve closest to the supply source shall be in a manhole.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

c.) Permanent taps shall be provided on each side of the valve within the manhole to allow insertion of a small meter to determine leakage and for sampling purposes.

6.3.17. Booster Pumps.

6.3.17.1 Inline booster pumps may be used if necessary to sustain required operating pressures in the water distribution system. Pumps shall be installed in a pump station so that they are accessible for servicing and repairs.

6.3.17.2 Booster pumps shall be located or controlled so that:

a.) there will be a minimum pressure of 20 psi in all distribution system lines at the suction side,

b.) automatic or remote control devices shall have a range between the start and cutoff pressure which will prevent excessive cycling,

c.) a bypass is available, and

d.) suction line should not be buried.

6.3.17.3 Each booster pumping station shall contain not less than two pumps with capacities such that peak demand can be satisfied with the largest pump out of service.

6.3.17.4 All booster pumping stations shall contain a totalizer meter.

6.3.17.5 Individual Service Booster Pumps. The use of individual service booster pumps for any service (domestic, commercial, industrial) from the public water supply main shall not be allowed unless specifically approved by the Commissioner.

6.3.18 Testing Water Lines

6.3.18.1 All newly laid water lines shall be tested prior to flushing and sterilization. Trenches may be backfilled as the pipe and accessories are installed, where practicable, at the option of the Developer/Contractor. Trenches over the joint locations may be left open for visual inspection during tests. Prior to making tests, all air shall be expelled from the lines. If hydrants or blow-offs are not available, suitable taps shall be provided by the Developer/Contractor for this purpose at or near the end points of the installation.

6.3.18.2 Pressure and leakage testing. All pipe and fittings shall be pressure tested and leakage tested in accordance with the latest edition of ANSI/AWWA C600 AWWA Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances (DI pipe) or ANSI/AWWA C605 AWWA Standard for Underground

6. WATER SUPPLY

Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water (PVC pipe) as applicable.

6.3.18.3 Any leaks evident at the surface shall be uncovered, repaired, and/or replaced. All leaking joints shall be tightened, or remade, or replaced, and re-tested. All pipe, fittings, valves, or other accessories found defective under this test shall be removed and replaced at the Contractor's expense.

6.3.19 Flushing and Sterilizing Water Lines

6.3.19.1 All new, cleaned, or repaired water mains shall be disinfected in accordance with the latest ANSI/AWWA C651 AWWA Standard for Disinfecting Water Mains.

6.3.19.2 The Developer/Contractor shall submit the method proposed to the Commissioner for approval. Included with the submittal shall be specifications of the method proposed. The specifications shall include detailed procedures for the adequate flushing, disinfection and microbiological testing of all water mains.

6.3.20. Handling of Materials

6.3.20.1 Under no circumstances shall pipe, fittings, valves, or other accessories, be dropped to the ground, or otherwise subjected to possible damage from impact or shock

6.3.20.2 Protection of Materials, Coatings, and/or Linings: All materials shall be handled in such manner that neither the coatings or the linings will be damaged. Under most circumstances, damage to outside coatings are repairable, and the necessary repairs shall be properly made prior to installation. Damage to interior linings are not considered repairable, and therefore, the damaged item shall be replaced.

6.3.19.3 Handling Materials Into Trench. Fittings, valves, and other accessories shall be carefully lowered into the trench or excavation, to protect coatings and linings. Under no circumstances shall any materials be dropped or dumped into the trench.

6.3.21 Clean-up. Following completion of water main installation, all required excavation shall be suitably backfilled to grade. All remaining debris, of whatever nature, shall be picked up and removed from the site. After clean-up, the disturbed area shall be smoothed to grade, seeded, and covered with straw. The entire work area at all crossing locations shall be left in an orderly, clean, and acceptable condition.

6.4. WATER SERVICES

6.4.1 Backflow Prevention

6.4.1.1 The water system must be protected from introduction of contaminants by backflow. Any connection to a backflow hazard shall be provided with a backflow prevention assembly.

6.4.1.2 Class I Backflow Hazard.

6.4.1.2.1 A Class I backflow hazard is one which presents an immediate or potential health hazard to customers of the water system. It shall be provided with either air-gap separation or a reduced-pressure principle backflow-prevention assembly.

6.4.1.2.2 Air-Gap Separation. Air-gap separation is created by a physical separation between the free-flowing discharge end of a water system pipeline and an open non-pressurized receiving vessel. The discharge pipe of an air-gap shall terminate a minimum of two (2) pipe diameters of the discharge pipe above the flood level rim of the receiving vessel. In no case shall the air-gap separation be less than one (1) inch.

6.4.1.2.3 Backflow prevention assemblies shall conform to the requirements of ANSI/AWWA C511, AWWA Standard for Reduced-Pressure Principle Backflow-Prevention Assembly. The assembly shall be installed as follows:

- a.) no plug or additional piping may be affixed to the pressure relief valve port other than an air-gap funnel arrangement designed specifically for the particular device.
- b.) the pressure relief valve port shall be at least twelve (12) inches above the floor level.
- c.) located so that any leak from the pressure relief valve port will be easily detected.
- d.) have easy access for maintenance and testing.
- e.) be protected from freezing and against excessive heat.

6.4.1.3 Class II Backflow Hazard. A Class II backflow hazard is one that would threaten to degrade the water quality of the water system should a backflow occur. Backflow prevention assemblies shall conform to the requirements of ANSI/AWWA C510, AWWA Standard for Double Check Valve Backflow-Prevention Assembly.

6. WATER SUPPLY

Assemblies shall be installed to insure easy access for maintenance and testing and be protected from freezing and against excessive heat.

6.4.2. Domestic Water Service Connections. Domestic water services shall be installed in accordance with one of the following standard details, as applicable:

a.) Design Detail WS.03, Sheet 1 of 2 Domestic Service Connection, Meter in Vault, $\frac{3}{4}$ " through 2" Diameter, or

b.) Design Detail WS.03, Sheet 2 of 2 Domestic Service Connection, Meter in Basement, $\frac{3}{4}$ " through 2" Diameter.

6.4.3 Industrial Water Service Connections. Industrial water services shall be installed in accordance with Design Detail WS.06 Industrial Service Connection, Meter in Vault, 3" through 6" Diameter. If a service line smaller than 3" diameter is required, installation may be made in accordance with one of the domestic Design Details, WS.03, Sheet 1 or 2.

6.4.4 Commercial Water Service Connections. Depending on water demand, commercial water services shall be installed in accordance with either domestic or industrial service design standards described in paragraphs 6.4.2 or 6.4.3. above.

6.4.5 Regardless of type of service (domestic, industrial, commercial) each service connection should be individually metered. Each apartment, condominium, store, business, manufacturer, etc. occupying space in a building shall have its own meter.

6.5. DOCUMENTATION REQUIRED

6.5.1 Plans and Specifications Required.

6.5.1.1 Every Developer must submit to the MoDNR and the Department reports, plans and specifications prepared by an Engineer for review and issuance of written approval to construct prior to initiating construction of a new (or expansion to existing) water supply source, water treatment facility, water pumping facility (except for booster pumps in water distribution systems) and water storage facility.

6.5.1.2 Every Developer must submit to the Department reports, plans and specifications prepared by an Engineer for review and issuance of written approval to construct prior to initiating construction new water distribution facilities and expansion or modifications to existing City water distribution facilities.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

6.5.1.3 Engineering reports, plans and specifications shall follow in form and content the requirements of the latest edition of Design Guide for Community Public Water Supplies, published by the MoDNR, Public Drinking Water Program.

6.5.2. Documentation to be Furnished to the City of Pacific.

6.5.2.1 In addition to design plans and specifications, it is the responsibility of the developer and/or installer³ to furnish a complete set of as-built drawings and product specifications/data to the City for public record. This information will be used to verify that the system was built in accordance with plans and specifications and to service and maintain the public water supply system in the future.

6.5.2.2 The following list of data and information shall be furnished by the developer and signed and sealed by a Professional Engineer licensed to practice in the State of Missouri:

a.) As-built drawings showing location of lines, fittings and all appurtenances e.g. valves, hydrants, meters, etc. Location shall include horizontal and vertical location. Horizontal location shall be measured from some fixed surface feature, e.g. curbing, property corner monument, etc. Vertical location shall be reported in depth below ground surface. Accuracy of measurement shall be at least ± 1 ft horizontally, ± 0.1 ft. vertically.

b.) An updated flow analysis, based on as-built conditions.

c.) Results of all flow and pressure tests.

d.) Certification of system disinfection.

6.5.2.3 In addition to the data as specified in paragraph 6.6.2.B. above, the developer/ installer shall furnish the documentation listed in Table 6-4. This documentation shall be signed and certified by the developer, installer, manufacturer, tester, and/or engineer.

³ The terms "developer" and "installer" are used interchangeably. If installation is done by a separate person or firm under contract to a developer, both parties must provide affidavits of certification. If the installer and the developer are the same person or firm, then the developer should sign the affidavit(s) as both the developer and the installer. Signatures shall be those of an officer or principal of the organization, e.g. owner, president, vice-president.

6. WATER SUPPLY

Table 6-4
Documentation to be Certified and Furnished by Developer

AWWA Spec.	Title	Mfg. Certify *	Develpr Certify	Mfg Dwgs& Manuals	Test Records	Mfg. Warrant
C-104	Cement-Mortar Lining for DI Pipe & Fittings	✓✓	✓✓			
C-105	PE Encasement for DI Pipe Systems		✓✓			
C-110	DI & Gray Iron Fittings, 3" through 48"	✓✓	✓✓			
C-111	Rubber-Gasket Joints for DI Pipe & Fittings	✓✓	✓✓	✓✓		
C-115	Flanged DI Pipe with DI or Gray Iron Threaded Flanges	✓✓	✓✓			
C-150	Thickness Design of DI Pipe		**			
C-151	DI Pipe, Centrifugally Cast	✓✓	✓✓			
C-153	DI Compact Fittings, 3" thru 24" & 54" thru 64"	✓✓	✓✓	✓✓		
C-502	Dry-Barrel Fire Hydrants	✓✓	✓✓	✓✓	✓✓	
C-509	Resilient-Seated Gate Valves	✓✓	✓✓	✓✓	✓✓	
C-510	Double Check Valve Backflow-Prevention Assy	✓✓	✓✓	✓✓		
C-511	Reduced Pressure Principle Backflow-Prevention Assy	✓✓	✓✓	✓✓		
C-512	Air-Release, Air/Vacuum, and Combination Air Valves	✓✓	✓✓	✓✓		
C-600	Installation of DI Water Mains and Their Appurtenances		✓✓ ##			
C-605	Underground Installation of PVC Pressure Pipe & Fittings		✓✓ ##			
C-651	Disinfecting Water Mains		✓✓ ##			
C-700	Cold-Water Meters - Displacement Type, Bronze Main Case	✓✓	✓✓	✓✓	✓✓	✓✓
C-702	Cold-Water Meters - Compound Type	✓✓	✓✓	✓✓	✓✓	✓✓
C-800	Underground Service Line Valves and Fittings	✓✓	✓✓	✓✓	✓✓	
C-900	PVC Pressure Pipe, 4" thru 12" for Water Distribution	✓✓	✓✓			
C-905	PVC Water Transmission Pipe, Nominal Dias. 14" thru 36"	✓✓	✓✓			

Notes:

✓✓ Documentation required.

* Manufacturer's certification to include transcripts of foundry records for DI pipe and fittings.

** Developer/installer to furnish pipe thickness calculations signed and sealed by a Professional Engineer licensed in the State of Missouri.

Developer/installer to certify that work was done in accordance with AWWA specification, describe QA/QC procedures employed and to furnish as-built drawings signed and sealed by a Professional Engineer licensed in the State of Missouri

This page is intentionally blank

SECTION 7

RESERVED FOR FUTURE USE

SECTION 8

**MATERIAL SPECIFICATIONS &
PLACEMENT INSTRUCTIONS**

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

8.1 AGGREGATES

8.1.1 General Requirements

8.1.1 Aggregates for roadway base construction or trench backfill shall be crushed limestone or dolomite. It shall not contain more than fifteen (15) percent deleterious rock and shale.

8.1.2 Aggregates shall not be placed on a frozen subgrade nor on subgrade that has not been prepared, tested, or inspected.

8.1.3 The maximum compacted thickness of any one layer shall not exceed six (6) inches. If the specified compacted depth exceeds 6 inches, the total thickness shall be divided into two or more layers of approximately equal thicknesses.

8.1.4 If the contractor elects to construct concrete pavement by slip-form methods, the width of the aggregate base course shall be increased to provide a 3-foot width outside the edge of the pavement being placed.

8.1.5 For pavement bases, immediately before spreading the mixture, the subgrade shall be sprinkled. The aggregate shall be uniformly spread in successive layers of such depth that when compacted the base will have the thickness specified.

8.1.6 All aggregates, regardless if pavement base or trench backfill, shall be compacted to a density of ninety-five (95%) standard proctor. Compaction tests are required at a minimum frequency of 200 feet. Each lift shall be tested. No fill may be placed on any area until said area passes the compaction test. A failing area may be reworked in order to achieve the necessary compaction or the area failing may be excavated to a passing lift (under the direction of the City Engineer or the soil testing company) and new material may be placed to achieve the compaction limits.

8.1.2 Definition of Types of Aggregates

8.1.2.1 Type 1 Aggregate. Type 1 aggregate shall be essentially limestone or dolomite. It shall not contain more than fifteen (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:

	<i>Percent</i>
Passing 3-inch sieve	100
Passing 1 ½-inch sieve	75 - 90
Passing ½-inch sieve	45 - 75
Passing No. 40 sieve	15 - 45

PACIFIC DESIGN & CONSTRUCTION STANDARDS

Passing No. 200 sieve

0 - 25

The fraction passing the No. 40 sieve shall have a plasticity not to exceed six.

8.1.2.2 Type 2 Aggregate. Type 2 aggregate shall consist of crushed stone, sand and gravel, or chat with or without soil binder. If crushed stone is used, 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. It shall not contain more than fifteen (15) percent deleterious rock and shale. Deleterious rock, shale, sand or binder if required shall be uniformly distributed throughout the mass. The aggregates combined with binder if required shall conform to the following gradation requirements:

	<i>Percent</i>
Passing 1-inch sieve	100
Passing ½-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 not to exceed six.

Type 2 Aggregate shall be same as MoDOT Type 1 Aggregate.

8.1.2.3 Type 3 Aggregate. Type 3 aggregate shall consist of a uniform mixture of washed crushed limestone or dolomite. Aggregates shall consist of sound durable particles. When tested in accordance with AASHTO T 96, the percentage of wear shall not exceed 55. The percentage of deleterious substances shall not exceed the following values and the sum of these percentages shall not exceed 8 percent.

	<i>Percent by Weight</i>
Deleterious rock	8.0
Shale and Mudballs	4.0

The material shall at all times during loading, hauling, and placing, contain sufficient moisture to prevent segregation and to aid in obtaining compaction. Washed sand and gravel mixtures shall meet the following gradation requirements:

	<i>Percent</i>
Passing 1-inch sieve	100
Passing ½-inch sieve	55 - 90
Passing No. 4 sieve	8 - 40
Passing No. 10 sieve	0 - 15
Passing No. 200 sieve	0 - 4

Type 3 Aggregate shall be same as MoDOT Type 4 Washed Crushed Stone Aggregate.

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

8.1.2.4 Type 4 Aggregate. Type 4 aggregate shall consist of a uniform mixture of washed crushed limestone or dolomite. Aggregates shall consist of sound durable particles. When tested in accordance with AASHTO T 96, the percentage of wear shall not exceed 55. The material shall at all times during loading, hauling, and placing, contain sufficient moisture to prevent segregation and to aid in obtaining compaction. Washed sand and gravel mixtures shall meet the following gradation requirements:

	<i>Percent</i>
Passing ½-inch sieve	100
Passing 3/8-inch sieve	40 - 90
Passing No. 4 sieve	8 - 40
Passing No. 10 sieve	0 - 15
Passing No. 200 sieve	0 - 4

8.2 ASPHALTIC CONCRETE

8.2.1 Composition of Mixtures. Prior to mixing with asphalt cement the total aggregate, including filler if needed, shall meet the following gradation for the type of mixture specified.

Table 8-1
Asphaltic Concrete - Percent Passing by Weight

Sieve Size	Type X	Type C & all others
1 inch	100	--
3/4 inch	80 - 100	100
1/2 inch	60 - 85	90 - 100
3/8 inch	50 - 75	60 - 90
No. 4	35 - 55	40 - 65
No. 8	25 - 40	25 - 45
No. 16	15 - 30	18 - 35
No. 30	10 - 20	12 - 25
No. 50	6 - 15	7 - 19

8.2.2 Hauling Equipment

8.2.2.1 Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum quantity of lime solution or an approved bituminous mixture release agent to prevent the mixture from adhering to the

PACIFIC DESIGN & CONSTRUCTION STANDARDS

beds. Use of diesel fuel, fuel oil or other detrimental products as a bed coating will not be allowed.

8.2.2.2 Each truck shall have a cover of canvas or other suitable material of such size as to protect the mixture from the weather. The cover shall be securely fastened over all sides of the truck bed. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed during daylight, unless there is adequate lighting in the area of work.

8.2.3 Pavers. Bituminous pavers shall be self-contained units, provided with an activated screen or strike-off assembly heated if necessary, and capable of spreading and finishing asphaltic concrete in lane widths applicable to the specified typical sections and thicknesses shown on the plans. The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed or strike-off. For screed extensions greater than one foot, the distribution system will be increased accordingly. The screed or strike-off assembly shall be equipped with an automatic control device and shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. When laying mixtures, the paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture. Equipment used for shoulders and similar construction shall be capable of spreading and finishing the courses in widths shown on the plans.

8.2.4 Rollers. All rollers, vibrators, or other equipment used to compact the asphaltic mixture shall be in satisfactory working condition. All rollers shall be capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Pneumatic tire rollers shall be self-propelled, of the oscillating-type, and equipped with smooth tires of equal size, diameter, and ply rating, all maintained at the same inflation pressure. The contractor shall furnish, if required, evidence regarding tire size, pressure, and loading. Rollers shall have a system for moistening each wheel or roll. Rollers shall be of a size and used in sufficient numbers to achieve specified compaction.

8.2.5 Weather Limitations. Asphaltic concrete 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 50 degrees Fahrenheit, (2) on any wet or frozen surface, (3) when weather conditions prevent the proper handling or finishing of the mixture, or (4) between October 1 and April 1 except when authorized by the engineer and the commissioner. Placement within these dates will be permitted provided all other conditions are met.

8.2.6 Spreading and Finishing.

8.2.6.1 The base course, primed or tacked surface, or preceding course or layer shall be cleaned of all dirt, packed soil, or any other foreign material prior to spreading

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

the asphalt mixture. The mixture, when delivered to the spreading and finishing machine, shall have a temperature of not less than 260 degrees Fahrenheit and be within 25 degrees Fahrenheit of that specified by the engineer. If lumps are present or a crust of mixture has formed, the entire load shall be rejected. The paver shall be operated at a speed that will give the best results. The rate of delivery of the mixture to the paver shall be coordinated so as to provide a uniform rate of placement without intermittent operation of the paver.

8.2.6.2 The thickness and width of each course shall conform to the typical section. The contractor may elect to construct each course in any number of layers; but no individual layer shall have a compacted thickness greater than 3 inches for Type X mixtures or 2 inches for all other types.

8.2.6.3 For pavements having a width of 16 to 24 feet, inclusive, the asphaltic concrete pavement shall be laid in lanes approximately one half the full width of the completed pavement and the full width completed as soon as practicable. Unless otherwise permitted by the Commissioner, a single lane of any course shall not be constructed to a length which cannot be completed to full width of the pavement the succeeding operating day. For pavements greater than 24 feet wide, single lane width construction shall be limited to one day's production and completion to full width shall be accomplished as soon as practicable.

8.2.6.4 No segregation will be permitted in handling the mixture at the plant, from the truck, or during spreading operations on the roadbed. All layers shall be feathered out, by hand raking if necessary, in transitioning the depth of the surface to meet present grades at bridges or ends of projects, to provide a uniform, smooth riding surface free of irregularities.

8.2.6.5 If the asphaltic concrete construction consists of more than a single layer, each layer shall be compacted as specified and allowed to cool to the ambient temperature before the next layer is placed. The contractor shall keep traffic off the asphaltic concrete until it has cooled sufficiently to prevent flushing of the asphalt to the surface, marking or distorting the surface, or breaking down the edges and in any case, until the surface of the asphaltic concrete is 140 degrees Fahrenheit or below. The final surface layer shall be laid in the same sequence over the entire project as the previously constructed layers unless otherwise approved by the engineer and commissioner.

8.2.7 Automatic Screed Control. The use of automatic screed control devices will be required except for paving small irregular areas, entrances, and side road connections. The screed of the mechanical spreading and finishing machine shall be regulated by an automatically controlled grade leveling and slope control device. The device shall be of a standard commercial quality adapted to the type of paver used and shall provide control for producing a uniform surface to the established grade, and a cross slope conforming to the requirements of the typical section. The device shall also be equipped with the necessary controls to permit the operator to adjust or vary the slope throughout superelevated curves.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

8.2.8 Compaction. After the asphaltic mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. Rolling shall begin as soon after spreading the mixture as it will bear the weight of the roller without undue displacement. The type and number of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. A pneumatic tire roller shall be used as the initial or intermediate roller on any course laced as a wedge or leveling course. All rolling shall be completed prior to the surface temperature of the mixture decreasing to 175 degrees Fahrenheit.

8.2.8.1 A dual drum vibratory roller of a type specifically designed for the compaction of asphaltic mixtures may be used for initial rolling. A dual drum vibratory roller meeting the requirements for a steel wheel roller and operating in the static mode may be used as the finish roller. Except for projects involving small quantities of mixture, a single vibratory roller shall not be used as both the initial roller and final roller. The roller shall be equipped with a dual amplitude system and shall have a minimum frequency of 1500 vibrations per minute. The roller shall also be equipped with a speedometer that accurately indicates roller speed in maximum increments of either $\frac{1}{2}$ mile per hour or 50 feet per minute. The roller controls shall include a device that prevents the roller from traveling in excess of $2\frac{1}{2}$ miles per hour when the roller is in a vibratory mode. If satisfactory compaction is not being obtained, the contractor shall cease using the vibratory roller.

8.2.8.2 Rollers shall move at a slow but uniform speed with the drive roll or wheels nearest the paver. Rolling shall begin at the sides and proceed longitudinally parallel to the road center line, each trip overlapping one half the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint shall be rolled first followed by the regular rolling procedure. On superelevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the center line. Alternate trips of the roller shall be terminated in steps to prevent the formation of surface irregularities. The alternate stops shall be spaced in such manner that any excess water will drain quickly. Lateral or diagonal rolling may be permitted to remove high spots, provided the rolling is done in such manner and at such time that shoving or cracking will not result.

8.2.8.3 Any displacement occurring as a result of starting, stopping, or changing direction of a roller, or from other causes, shall be avoided. Areas of displacement shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the asphaltic concrete. If necessary to prevent adhesion of the mixture to the rollers, the wheels and rolls shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted. Diesel fuel, fuel oil, or other detrimental products shall not be used as wetting agents. Along forms, curbs, headers, walls, and other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons, or with mechanical tampers. A trench roller shall be used on depressed areas inaccessible to regular width equipment.

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

8.2.8.4 Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh, hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of asphalt cement shall be removed and replaced.

8.2.8.5 Except as otherwise specified, rolling shall be continued until all roller marks are eliminated and a minimum density of 98 percent standard proctor. Density shall be determined by nuclear methods or by specific gravity method. The direct transmission nuclear method of test will be used for all types except Type X which are placed in layers 2 inches thick or thicker, and for Type X mixtures only when used in lieu of plant mix bituminous base in layers 2 inches thick or thicker. The backscatter nuclear method of test will only be used for mixtures constructed in layers less than 2 inches thick. Results of the testing may be requested by the City and furnished by the contractor at no expense to the City.

8.2.9 Joints.

8.2.9.1 Transverse joints shall be formed by any method that will produce a dense, vertical section for use when laying is resumed. The joint formed when the fresh mixture is placed shall be dense, well sealed, and the grade, line and surface texture of the succeeding surface shall conform to that of the joined surface. If deemed necessary by the engineer, the transverse joint shall be painted with a light coating of asphaltic material. Hand manipulation of the mixture is to be minimized to avoid unsightly surface texture. Placing of asphaltic mixture shall be as nearly continuous as possible and the roller shall not pass over the unprotected end unless laying of additional mixture is to be delayed for sufficient time to permit the mixture to become chilled.

8.2.9.2 Longitudinal Joints

8.2.9.2.1 Longitudinal joints shall be formed by the use of an edging plate fixed on both sides of the finishing machine. These plates shall be adjustable and the outside plate shall be set at an angle of approximately 45 degrees with the surface of the roadbed and in a position that will lightly compact the mixture. The inside plate, or that placing material for the longitudinal joint, shall be normal to the roadbed. When placing the first lane, if the mixture at the longitudinal joint tends to slump, it shall be set up to a vertical edge by light compaction with the back of a rake. Care shall be taken to obtain a well bonded and sealed longitudinal joint by placing the hot mixture in a manner insuring maximum compaction at this point. If it is deemed necessary by the engineer in properly sealing the longitudinal joint, a light coating of asphaltic material shall be applied to the exposed edge before the joint is made. Irregularities in the outside edge alignment shall be corrected by removing or adding mixture before the surface is compacted.

8.2.9.2.2 The longitudinal joint in any layer shall offset that in the layer immediately below by approximately 6 inches; however, the joints in the completed surfacing shall be at the lane lines of the travel way.

PACIFIC DESIGN & CONSTRUCTION STANDARDS

8.2.10 The surface of each layer shall be substantially free from waves or irregularities. As soon as practicable, the pavement surface shall be thoroughly tested by profilographing or straightedging. The final surface shall not vary from a 10-foot straightedge, applied parallel to the center line, by more than 1/8 inch. At transverse construction joints, the surface of all other layers shall not vary from the 10-foot straightedge by more than 1/4 inch.

8.3 PORTLAND CEMENT CONCRETE

8.3.1 General. All concrete shall be air entrained with an air content of four percent (4%) to six percent (6%), have a maximum slump of four (4) inches, and be the equivalent of a six and one-quarter (6¼) bag mix which shall be capable of developing a compressive strength of 4,000 pounds per square inch (psi) in twenty-eight (28) days. Addition of calcium in any form is prohibited. The aggregate used in concrete for curb and gutters shall be a maximum size of one (1) inch and aggregate used in concrete for streets shall be a maximum size of one and one-half (1½) inch.

8.3.2 Hauling.

8.3.2.1 Truck mixed concrete shall be mixed at the proportioning plant and the mixer shall operate at agitating speed while in transit. However, truck mixed concrete may be mixed at the point of delivery provided the cement, or cement and mixing water, are added at that point. Mixing of truck mixed concrete shall begin immediately after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregate.

8.3.2.2 Mixing speed for the revolving drum type of mixer shall be not less than 6 nor more than 18 revolutions of the drum per minute. Agitating speed for both revolving drum mixers and revolving blade type agitators shall be not less than 2 nor more than 6 revolutions per minute of the drum or of the mixing blades. Truck mixed concrete shall initially be mixed not less than 70 nor more than 100 revolutions of the drum at mixing speed after all of the ingredients, including water, are in the drum or 91 percent of the rated maximum capacity, the number of revolutions required for mixing shall be not less than 50 nor more than 100. When a truck mixer or truck agitator is used for transporting concrete that has been completely mixed, agitation of the concrete shall continue during transportation at the speed designated by the manufacturer of the equipment as agitating. Water may be added to the mixture not more than two times after initial mixing is completed. Each time water is added, the drum shall be turned an additional 30 revolutions or more if necessary, at mixing speed, until uniform mixing is accomplished.

8.3.2.3 Central or truck mixed concrete shall be delivered to the site of the work and discharge shall be completed within 1½ hours after the beginning of the mixing operations. In hot weather or under conditions contributing to quick stiffening of the concrete, the time shall be reduced as specified by the engineer. Concrete shall be

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

discharged without delay and the time required between the start and completion of the discharge shall not exceed 15 minutes.

8.3.2.4 During the time that concrete is being discharged for pours requiring more than one load of concrete, facilities shall be provided to permit immediate radio communication between the site where the concrete is being placed and the proportioning plant.

8.3.2.5 Delivery Ticket. The manufacturer of truck mixed concrete, and of central mixed concrete shall furnish to the contractor with each truck load of concrete before unloading at the site, a delivery ticket on which is shown information concerning the concrete as follows. This information shall be filed and be made available to the Commissioner at any time.

- a.) Name of concrete plant.
- b.) Serial number of ticket.
- c.) Date and truck number.
- d.) Name of contractor.
- e.) Specific project, route, and county designation.
- f.) Specific class of concrete.
- g.) Quantity of concrete in cubic yards.
- h.) Time when batch was loaded, or of first mixing of cement and aggregates.

8.3.2.6 Consideration will be given for the use of an approved type of non-agitating equipment for transporting central mixed concrete provided the discharge of the concrete is completed within 30 minutes after the introduction of the mixing water to the cement and aggregates. Bodies of non-agitating hauling equipment shall be smooth, mortar-tight metal containers capable of discharging the concrete at a satisfactory, controlled rate without segregation. If unloading the concrete is accomplished by tilting the body, baffles may be required to retard the discharge. Covers shall be provided when needed for protection.

8.3.3 Forms.

8.3.3.1 Side forms, except as otherwise permitted, shall be of metal with a base width not less than the height. The height shall be equal to the edge thickness of the pavement. Each form section shall be straight and free from bends and warps. No section shall show a variation greater than 1/8 inch in 10 feet from the true plane surface on the top, and 1/4 inch in 10 feet along the face of the form. The method of connecting form sections shall insure a tight, neat joint. Built-up metal forms may be used by rigidly attaching a wood or metal section of suitable width and thickness to the bottom of the form providing an increase in depth of not more than 20 percent.

8.3.3.2 Forms for curved form lines shall comply with the grade and alignment as shown on development plans except that straight steel form sections 10 feet or

PACIFIC DESIGN & CONSTRUCTION STANDARDS

less in length may be used for form lines having a radius greater than 200 feet. Straight steel form sections 5 feet long will be acceptable for curved form lines having a radius of not less than 100 feet. Forms shall be of sufficient rigidity to prevent distortion in edge alignment due to pressure of the concrete. Wood forms shall not be used as a track for operating paving and finishing equipment.

8.3.3.3 Setting Forms. Forms shall be set so that they rest firmly throughout their length upon the thoroughly compacted subgrade. Any subgrade which is more than $\frac{1}{2}$ inch below the established grade at the form line shall be brought to grade for a sufficient width, outside the area required by the pavement, to support the forms adequately, and shall be thoroughly rolled. Any variations, whether below or above grade, shall be brought to true grade.

8.3.3.3.1 Forms shall be staked into place with not less than three pins for each 10-foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. After the forms have been set to correct grade, the material at both the inside and outside edges of the base of the forms shall be thoroughly tamped. Immediately prior to any tamping operations, a small ridge of approved fine graded material shall be placed along each side of the forms as necessary for use during tamping operations. If the subgrade becomes soft and yielding after the forms have been set and before the concrete is placed, the forms shall be reset on a stable foundation. If in the judgment of the engineer, the subgrade for the forms has been cut sufficiently accurate with automatically controlled equipment as to eliminate the need for tamping, the form tamping requirement may be waived.

8.3.3.2 Both straight and curved forms shall be supported in such position that the face of the form shall be vertical on tangents and perpendicular to the superelevated section on curves. The top of the form shall not vary more than $\frac{1}{8}$ inch from the true grade line during placing, compacting, and finishing operations. The form alignment shall not vary more than $\frac{1}{4}$ inch from the true alignment.

8.3.3.3 Unless otherwise permitted, sufficient forms shall be provided so that at least 500 feet of forms on each side of the roadbed are accurately set at all times in their required final position in advance of the point where concrete is being placed. Each time forms are used, they shall be cleaned thoroughly and oiled before reuse.

8.3.3.4 Conditioning of Subgrade. When forms have been securely set to grade, the subgrade shall be brought to proper cross section. The final checking for proper crown and elevation of the subgrade shall be performed in the presence of the engineer after all equipment traffic on the subgrade has ceased and as close as is practicable to the area of current concrete placement. If measurements taken when the surface of the pavement has been finished indicate that pavement thickness is less than specified on the plans, adjustments shall be made immediately.

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

8.3.4 Placing Concrete. The concrete shall be deposited over the entire width of the subgrade between forms in such manner as to prevent segregation and to require as little rehandling as practicable. Mixers used for pavement construction, including truck mixers and trucks used for transporting concrete, will not be permitted to discharge concrete by chute or by dumping directly on the subgrade, prepared base, or previously placed concrete except for areas to be hand finished or for isolated pavement lanes less than 2000 feet long. Concrete shall be thoroughly vibrated along the forms or sides and along expansion and key type longitudinal joints. Attachments on finishing machines to vibrate the concrete adjacent to forms and longitudinal joints will be permitted provided satisfactory results are attained. Care shall be taken that the vibrator does not penetrate the subgrade or dislodge or move the joints. The vibrating shall be sufficient to produce a smooth pavement edge. Honeycomb in the edge may be cause for the rejection of the pavement.

8.3.5 Vibrators. Vibrators, for full width vibration of the concrete, may be either the surface pan-type or the internal-type with either tube or multiple spuds. They may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the reinforcement, load transfer devices, subgrade, or side forms. Vibrating equipment shall be operated in accordance with the manufacturer's recommendation at a frequency to provide satisfactory results, but the frequency of the surface vibrators shall not be less than 3600 impulses per minute and the frequency of the internal-type shall not be less than 4500 impulses per minute. Hand vibrators shall have a frequency of not less than 4500 impulses per minute. The contractor shall have a satisfactory tachometer available at all times for checking the vibration frequency.

8.3.6 Strike-off of Concrete and Placement of Reinforcement.

8.3.6.1 Following the placing of the concrete, it shall be struck off so that when the concrete is properly consolidated and finished, the surface of the pavement will be at the proper elevation and cross section. Reinforced concrete pavement shall be placed in two layers. The entire width of the bottom layer shall be struck off to such length and depth that the sheet of wire fabric may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall be placed directly upon the concrete, and the top layer of the concrete placed, struck off, and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the contractor's expense.

8.3.6.2 Tie bars shall be supported in the proper position by chairs driven into the subgrade, or may be placed by approved mechanical methods prior to the consolidation of the concrete after it has been struck-off.

8.3.6.3 Wire fabric and tie bars shall be free from dirt, oil, paint, grease, loose mill scale, and thick rust which could impair bond of the steel with the concrete. Thin, powdery rust need not be removed.

8.3.7 Final Strike-off, Consolidation, and Finishing.

8.3.7.1 Machine finishing by vibrating and screeding processes will be required for all pavement. After the final course of the concrete has been placed it shall be struck off and thoroughly vibrated until concrete of a uniform and satisfactory density is attained. The surface of the pavement shall be screeded as many times and at such intervals as necessary to leave a surface of uniform texture to the proper grade and typical section. Excessive screeding over a given area shall be avoided. Finishing machines shall be kept in satisfactory repair and adjustment and shall be operated without lift, wobbling, or other variation tending to affect a precision finish.

8.3.7.2 Concrete shall be consolidated by vibrating the mass promptly following placement. Vibrating tubes shall extend into the concrete the distance necessary to provide adequate consolidation.

8.3.7.3 After the finishing machine operations have been completed, the concrete surface shall be smoothed and consolidated by mechanical floating, either longitudinal or transverse, leaving the pavement finished to the required cross section, elevation, and surface smoothness. The longitudinal float shall pass over each area of pavement at least two times.

8.3.7.4 The finishing machine, when in operation, shall be equipped with at least two oscillating-type transverse screeds supported by the forms. It shall satisfactorily handle and finish the mixes required for this type of construction and shall not displace the reinforcement, side forms, or joints.

8.3.7.5 After surface irregularities have been removed, the concrete shall be given a uniformly roughened surface finish by use of a wire comb or other approved texturing device which produces a texture similar to that produced by a wire comb. The texturing operation shall be executed so that the transverse corrugations will be uniform in appearance. Successive passes of the comb or other approved device shall be overlapped the minimum necessary to attain a continuously textured surface. The surface texture produced shall have the characteristics of a texture produced by a wire comb which has an average texture depth of approximately 0.125 inch. Texturing shall be completed while the concrete is in such condition that it will not be torn or unduly roughened and before it has attained its initial set. Upon completion of texturing, the pavement surface shall be uniform in appearance and free from surplus water, rough or porous spots, irregularities, depressions, and other objectionable features. Small or irregular areas, or areas not suitable for machine texturing when adjacent surrounding concrete is ready for texturing, shall be textured with a hand operated device producing a textured surface equivalent to that required for machine combing.

8.3.7.6 Either a suspended pan-type transverse float or a reciprocating longitudinal float will be required. The machine shall be of an approved design, in satisfactory working condition, and accurately adjusted to the specified crown.

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

8.3.7.6.1 Wire Comb. A wire comb shall be not less than 10 feet long with a single line of wires exposed to a length of approximately 4 inches. The wire shall be blue tempered and polished spring steel with nominal dimensions of 0.028 inch thick and 0.100 to 0.125 inch wide. The wires shall be spaced to provide $\frac{1}{2}$ inch clear space between wires and securely mounted in a rigid head with the width of each wire parallel to the longitudinal center line of the head. The wire comb shall be mechanically operated with the length of the comb parallel to the pavement center line and capable of traversing the full width of pavement in a single pass at a uniform speed and at a uniform depth. Texturing equipment, other than a wire comb, may be approved provided it produces a texture equivalent to that produced by a wire comb and upon satisfactory performance during actual use.

8.3.7.6.2 Brooms of an approved type may be provided in lieu of the wire comb. The brooms shall be not less than 18 inches wide, made from good quality bass or bassine fiber not more than 5 inches long.

8.3.8 Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each form line, and of each side of transverse expansion joints and construction joints shall be worked with an edging tool having a radius of approximately $\frac{3}{8}$ inch. A well-defined and continuous radius having a smooth, dense finish shall be produced. The surface of the pavement shall not be unduly disturbed by tilting of the tool during use. Tool marks on the pavement shall be eliminated by brooming or dragging the surface. In doing this, the rounding of the corner of the pavement shall not be disturbed. All concrete on top of the joint filler shall be completely removed. All joints shall be tested with a straightedge before the concrete has set, and correction made if one side of the joint is higher than the other.

8.3.9 Joints.

8.3.9.1 Joints shall be of the specified type and dimensions, and constructed at the locations shown on the plans or as approved by the engineer. Where joints are pre-formed, the form or joint shall be set and securely fastened to insure the joint being in the required position when the concrete is finished. Dowels and tie bars in their final position shall be parallel to the subgrade and perpendicular to the line of the joint. Dowel supporting assemblies shall conform to one of the types shown on the plans. The concrete shall be placed so that it will not displace or disarrange the joint installations.

8.3.9.2 Expansion joints shall extend for the full cross section of the concrete pavement. Filler placed prior to the placement of the concrete shall be installed with a removable cap or edging bar to serve as a guide for edging the joint and protection for the filler during the placing and finishing of the concrete. Joints constructed after the placement of the concrete shall be sawed full depth and the exposed edges shall be ground to a chamfer of $\frac{3}{8}$ inch. The filler shall rest snugly on the subgrade from form to form. Upon removal of

the forms, any struts or fins of concrete extending across the joint shall be removed to the full width of the joint and the full thickness of the pavement.

8.3.9.3 Construction joints shall be made at the close of each day's work or when the work is stopped or interrupted for more than 30 minutes. No transverse construction joint shall be constructed within 10 feet of an expansion or contraction joint. Construction joints shall be constructed perpendicular to the top surface and the center line of the pavement. The final joint shall conform to the cross section of the pavement. Before paving operations are resumed, all surplus concrete and other refuse shall be removed from the subgrade.

8.3.9.4 Sawing. Unless otherwise provided, all transverse contraction and all longitudinal joints in the pavement shall be sawed with the joint groove cut to the dimensions shown on the plans. If the groove for poured type transverse joints is cut prior to removal of the forms, the groove shall be cut as close as is practicable to the pavement edge, and the resulting crescent shaped plug in the groove, immediately adjacent to the form, will be acceptable. Sawing of the joints shall begin as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling. All joints shall be sawed before uncontrolled shrinkage cracking takes place. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw.

8.3.9.5 Concrete Saw. If sawed joints are required, equipment shall be provided complete with either an abrasive wheel or a diamond-edge water-cooled blade, capable of providing a groove of the specified dimensions in the hardened concrete.

8.3.10 Sealing Joints

8.3.10.1 All sawed contraction joints and sawed or formed expansion joints shall be sealed with joint sealing material before the pavement is opened to traffic, including construction traffic, and as soon after completion of a minimum curing period of 72 hours as is practicable. Immediately prior to sealing, the joints shall be thoroughly cleaned and dried. The sealing material shall be heated to the pouring temperature recommended by the manufacturer. Any material which has been heated above the maximum safe heating temperature will be rejected. The sealing material shall be installed in such a way as to fill the joint opening completely and uniformly from the bottom to the top, and any excess material shall be removed from the pavement surface.

8.3.10.2 Equipment for Sealing Joints. An approved double boiler-type heating kettle equipped with a mechanical agitator and a satisfactory temperature indicating device will be required. The equipment shall be capable of heating the joint sealing material uniformly without damage.

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

8.3.11 Curing. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods. The concrete shall not be left exposed for more than ½ hour between stages of curing or during the curing period.

8.3.11.1 White Pigmented Membrane. After the free water has left the pavement surface, the entire surface shall be sealed by hand or machine spraying with a uniform application of white pigmented membrane curing material. The contractor shall provide satisfactory equipment to insure uniform coverage of curing material, without loss, on the pavement at the rate of one gallon for each 150 square feet. If rain falls on the newly coated pavement 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. All areas cut by finishing tools subsequent to the application of the curing material shall immediately be given new applications at the rate specified above. If hair-checking develops before the membrane can be applied, the concrete shall be initially cured with wet burlap before the membrane is placed.

8.3.11.2 Waterproofed Paper, Polyethylene Sheeting, and Polyethylene-Burlap Sheeting. As soon as the concrete has set sufficiently to prevent marring, the top surface of the pavement shall be covered with units of waterproofed paper, white polyethylene sheeting, or white polyethylene-burlap sheeting, which shall be lapped not less than 18 inches. If polyethylene-burlap sheeting is used, the burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All coverings shall be so placed and weighted that they remain in contact with the pavement surface and edges for not less than 72 hours after the concrete has been placed. If hair-checking develops before the covering can be applied, the concrete shall be initially cured with wet burlap before covering is placed.

8.3.11.3 Mats of Jute or cotton. New mats of jute or cotton, and any such mats that have been used for purposes other than the curing of concrete, shall be thoroughly washed before being used. The use of mats contaminated with earth or other deleterious substances will not be permitted. The top surface of the pavement shall be completely covered with mats as soon as the concrete has set sufficiently to prevent marring of the surface. Prior to being placed, the mats shall be damp throughout and shall be placed with the wettest side down. The mats shall be handled in such manner that contact with earth or other deleterious substance is avoided, and they shall be so placed that they remain in contact with the pavement surface and edges. The covering shall be kept wet and maintained in position for not less than 72 hours after the concrete has been placed. If hair-checking develops before the mats can be applied, the concrete shall be initially cured with wet burlap before the mat covering is placed.

8.3.11.4 Burlap. The top surface of the pavement shall be temporarily covered with thoroughly damp burlap after the concrete has set sufficiently to prevent marring of the surface. Burlap shall be handled in such a manner that contact with earth or

PACIFIC DESIGN & CONSTRUCTION STANDARDS

other deleterious substances is avoided. All new or contaminated burlap and all burlap which has been used for purposes other than the curing of concrete shall be thoroughly washed before being used. The burlap shall be kept thoroughly wet until removed for application of the final curing material. Neither the top nor the edge of the pavement shall be left unprotected for more than ½ hour. When the burlap is removed, curing shall be continued by one of the other approved methods.

8.3.11.5 Straw. The pavement shall be initially cured with wet burlap. As soon as the burlap is removed, the surface shall be covered with not less than 6 inches of straw, the thickness being measured after wetting. The straw shall be kept saturated for not less than 72 hours after the concrete has been placed. When removed, the straw shall be disposed of but shall not be burned on the pavement or in close proximity to the edges.

8.3.12 Removing Forms. Forms shall be removed carefully so as to avoid damage to the pavement. Honeycombed areas will be considered as defective work and shall be immediately repaired. If the forms are removed prior to 72 hours after placing concrete, the sides of the pavement shall be cured by one of the methods specified above. Any trench excavated for the forms shall be entirely backfilled so no water will stand next to the pavement.

8.3.13 Surface Test. As soon as practicable, the pavement surface shall be thoroughly tested by profilographing or straightedging. The final surface shall not vary from a 10-foot straightedge, applied parallel to the center line, by more than 1/8 inch. At transverse construction joints, the surface of all other layers shall not vary from the 10-foot straightedge by more than ¼ inch.

8.3.14 Opening to Traffic. The concrete pavement shall not be opened for light traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 3000 psi. The pavement shall not be opened to all types of traffic until the concrete is at least 120 hours old and has attained a minimum compressive strength of 3500 psi. Pavement shall be cleaned prior to opening to traffic.

8.3.15 Slip-form Construction. At the option of the contractor, pavement may be constructed by the use of siding form methods. The following shall apply in addition to other provisions outlined above.

8.3.15.1 Subgrade and Base. If an aggregate base course is specified for the pavement, it shall be constructed with requirements mentioned above. The slip-form paver shall operate on the aggregate base. After the grade or base has been placed and compacted to the specified density, the areas which will support the paving machine shall be cut to the proper elevation by means of an approved machine.

8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

8.3.15.2 Placing Concrete. A self-propelled concrete spreader equipped with a power-driven device for spreading the concrete uniformly across the subgrade transversely shall be used to place the concrete. The spreader shall also be equipped with an adjustable strike-off blade capable of striking off the surface of the concrete in the longitudinal direction of the pavement at any required elevation. The final surface texture may be applied manually with a wire comb. Concrete for reinforced concrete pavement shall be placed in two layers.

8.3.15.3 Consolidating and Finishing Equipment. The concrete shall be consolidated and finished by an approved slip-form paver designed to spread, consolidate, and shape the concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with the plans and specifications. The slip-form paver shall be fully energized, self-propelled, and crawler mounted. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown on the plans at an adequate forward speed, and without transverse, longitudinal, or vertical instability or displacement. The slip-form paver shall provide one oscillating transverse belt or other approved device that will produce a surface reasonably free of surface voids and tears. The machine shall vibrate the concrete for the full width and depth of the pavement being placed. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such distance that no apparent slumping of the concrete will occur 6 inches in from the pavement edge. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

8.3.15.4 Forms. Unless otherwise permitted by the engineer, approved side forms will be required 20 to 30 feet back and ahead of transverse expansion and construction joints. The forms shall incorporate a key-way where required and shall be sufficiently rigid to produce a pavement with plan section.

8.3.15.4.1 Longitudinal tongue and groove joints of the specified type and size shall be constructed at locations shown on the plans. Groove type joints shall be formed with approved metal forms that will produce a key-way with plan location and dimensions. The form shall remain in place for sufficient time to prevent slump and may be left in place with permission of the engineer. Tongue type joints may be constructed without forms provided the plan section of the pavement and joint can be maintained.

8.3.15.4.2 Where tie bars are required, they shall be used with groove type joints. The bars shall be positioned before pavement consolidation.

8.3.15.5 Protection Against Rain. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Protective material may consist of sheets of burlap, paper, or plastic film. Planks or other material with suitable stakes that can be used as temporary forms shall also be on hand. It is the contractor's responsibility to protect the pavement from damage due to rain. Failure to properly protect unhardened concrete may constitute cause for the removal and replacement of defective pavement at the contractor's expense.

8.3.16 Weather Limitations. Unless otherwise authorized in writing by the engineer, mixing and concreting operations shall be discontinued when a descending ambient temperature away from artificial heat reached 40 degrees Fahrenheit and not resumed until an ascending ambient temperature away from artificial heat reaches 35 degrees Fahrenheit.

8.3.16.1 If approval has been granted for the contractor to place the concrete while the ambient temperature is at or lower than 40 degrees Fahrenheit, the contractor shall 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 Fahrenheit, and the temperature of the aggregates and mixing water combined shall be not higher than 100 degrees Fahrenheit when the cement is added. Unless otherwise authorized, the temperature of the mixed concrete when heating is employed shall not be less than 50 degrees Fahrenheit and not more than 80 degrees Fahrenheit at the time of placement. Cement or fine aggregate containing lumps or crusts of hardened material or frost shall not be used. Concrete shall not be placed upon a frozen subgrade except with written approval of the engineer.

8.3.16.2 Protection. All concrete shall be effectively protected from freezing for a period of at least 5 days after it has been placed and until a minimum compressive strength of 3000 psi has been attained. Protection will be required for not more than 10 days. Regardless of precautions taken, the contractor shall assume all risks, and all frozen concrete shall be replaced at his expense.

8.3.16.3 Placing of concrete in the rain is discouraged. If the finish of the surface is damaged as a result of placing the concrete in the rain, it may be rejected by the City.

8.4 REINFORCING STEEL

8.4.1 General. Unless otherwise specified, reinforcement shall be deformed bars meeting the requirements of one of the following: AASHTO M 31, AASHTO M 42, or AASHTO M 53. Bars conforming to AASHTO M 42 and M 53 shall be in straight lengths only.

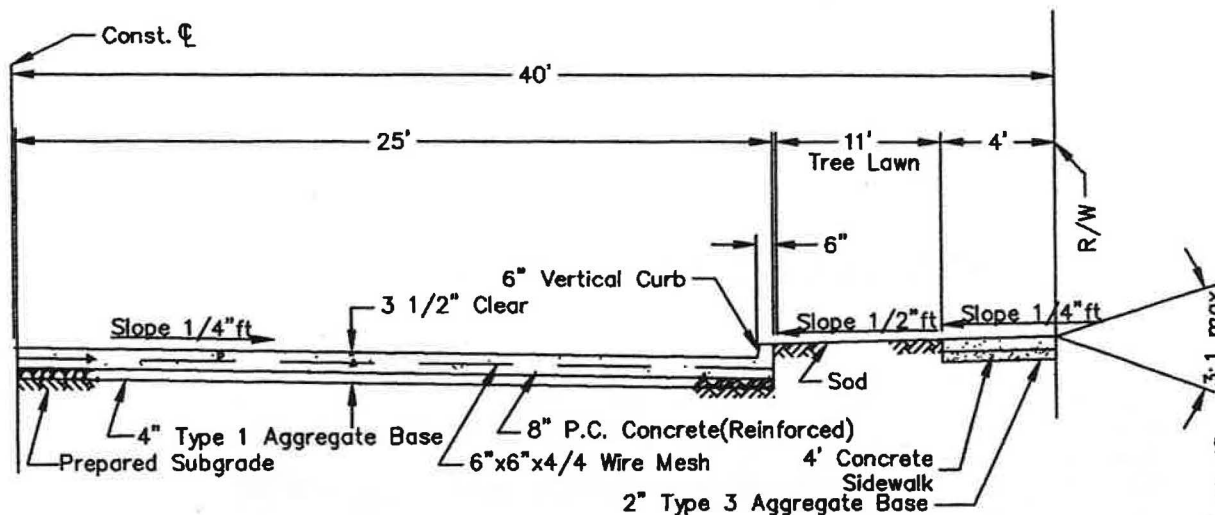
8. MATERIAL SPECIFICATIONS & PLACEMENT INSTRUCTION

8.4.2 Welded Wire Fabric for Concrete Pavement. Welded steel wire fabric reinforcement for concrete pavement shall meet the requirements of AASHTO M 55, except the requirements for weld shear tests and the variation of diameter of transverse wires shall be waived. It shall be in mats of the size and design shown on the plans. It will be permissible to furnish longitudinally hinged wire fabric for sheets of a required width of eight (8) feet or greater. The hinge shall be made by looping the transverse wires around a longitudinal wire, and shall be capable of developing the full strength of the transverse wire. The hinge shall be located within one foot of the center of the width of the sheet. All steel wire fabric shall be free from dirt, paint, oil, grease, thick rust, and other foreign substances. Thin powdery rust need not be removed.

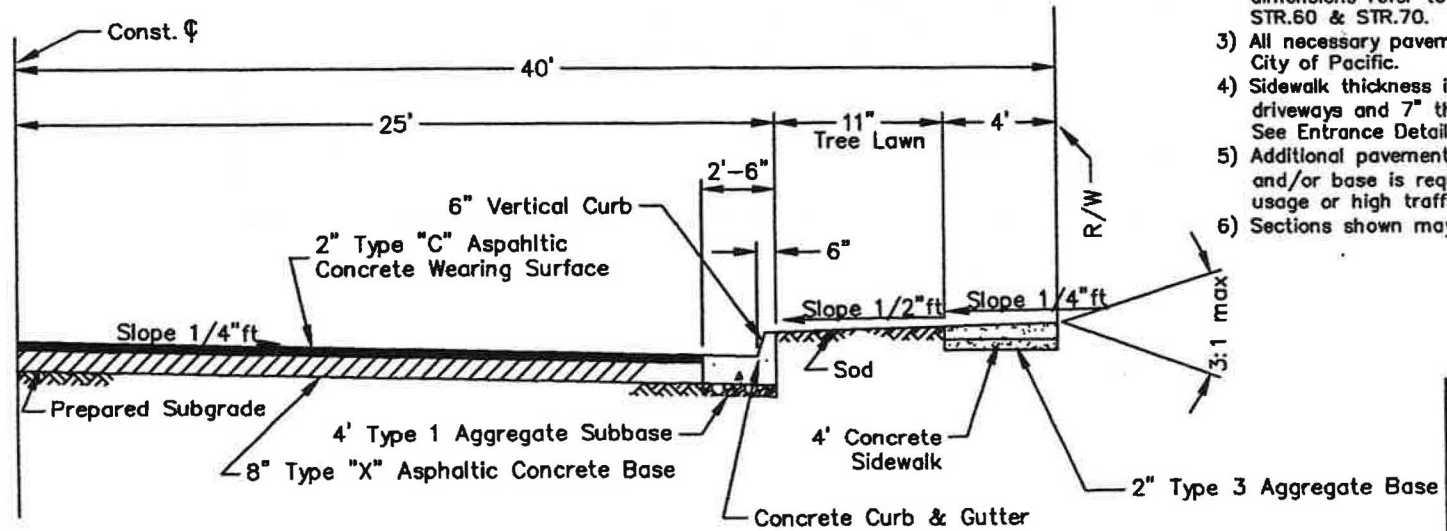
This page is intentionally blank

SECTION 9
STANDARD DESIGN DETAILS

1111 Y 2000



RIGID PAVEMENT (CONCRETE)



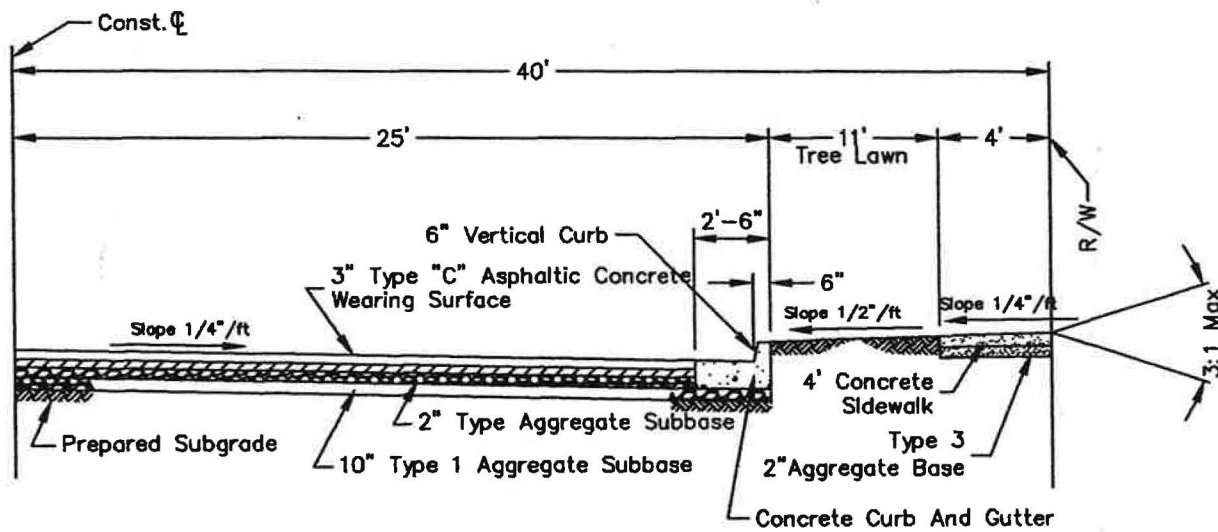
FULL DEPTH ASPHALT PAVEMENT

GENERAL NOTES:

- 1) Sections are symmetrical about construction centerline.
- 2) For longitudinal and transverse joints, dowel, and tie bar requirements and curb dimensions refer to Standard Details STR.25, STR.60 & STR.70.
- 3) All necessary pavement markings by the City of Pacific.
- 4) Sidewalk thickness is 4" thru Residential driveways and 7" thru Commercial driveways. See Entrance Details.
- 5) Additional pavement thickness, reinforcement and/or base is required for heavy vehicular usage or high traffic volumes.
- 6) Sections shown may not apply at intersections.

CITY OF PACIFIC, MISSOURI		
Standard Construction Details		
STANDARD TYPICAL SECTION		
ARTERIAL		
80' R/W 50' PVMT		
Dr. G.P.L.	2000	STR.01
Ch. R.L.B.		Sh 1

1111 Y 2000



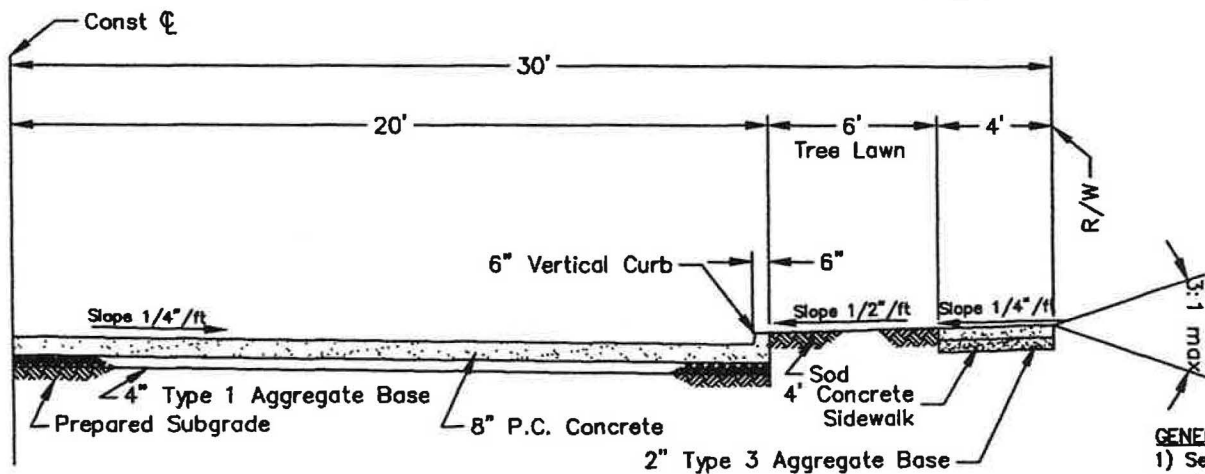
ASPHALT PAVEMENT WITH ROCK BASE

CITY OF PACIFIC, MISSOURI
Standard Construction Details

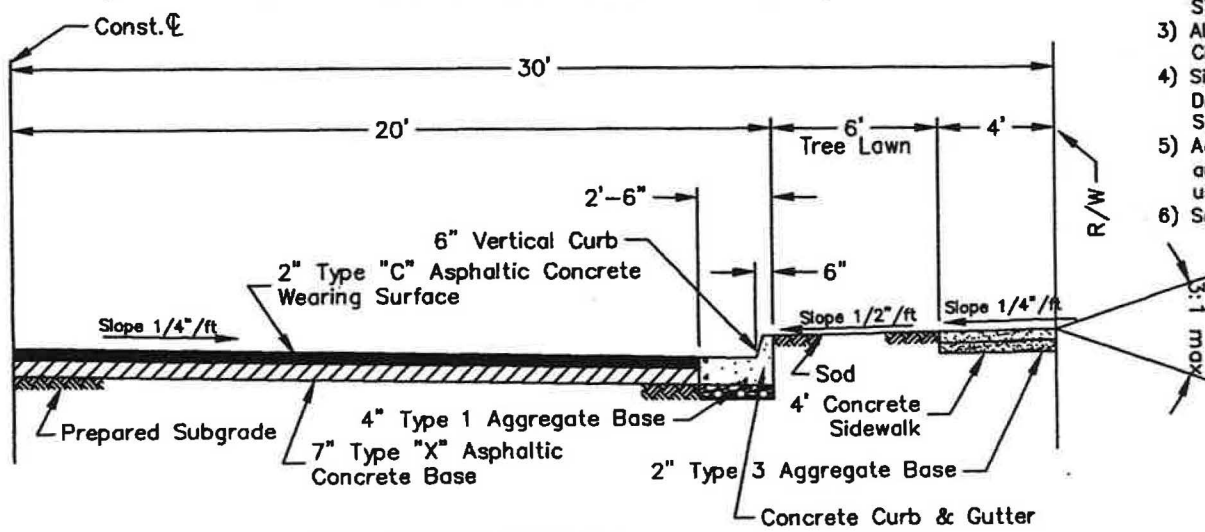
STANDARD TYPICAL SECTION
ARTERIAL
80' R/W 50' PVM T

Dr. G.P.L. Ch.R.L.B.	2000	STR.01 Sh 2
-------------------------	------	----------------

JULY 2000



RIGID PAVEMENT (CONCRETE)



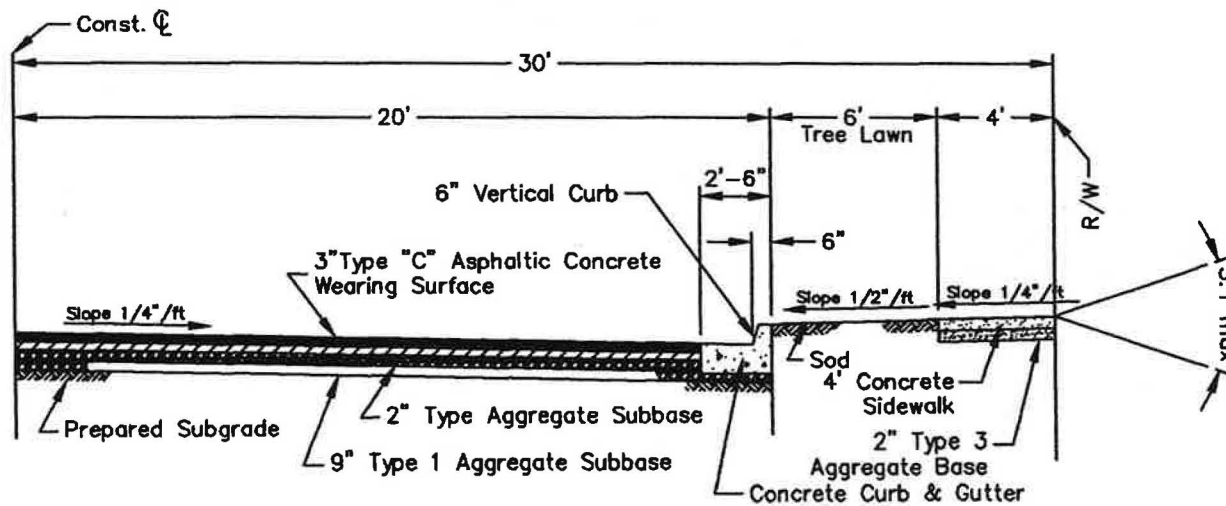
FULL DEPTH ASPHALT PAVEMENT

GENERAL NOTES:

- 1) Sections are symmetrical about construction centerline.
- 2) For longitudinal and transverse joints, dowel and tie bar requirements and curb dimensions refer to Standard Details STR.25, STR.60 & STR.70.
- 3) All Necessary pavement markings by the City of Pacific.
- 4) Sidewalk thickness is 4" thru Residential Driveways and 7" thru Commercial Driveways. See Entrance Details.
- 5) Additional pavement thickness, reinforcement and/or base is required for heavy vehicular usage or high traffic volumes.
- 6) Sections shown may not apply at intersections.

CITY OF PACIFIC, MISSOURI		
Standard Construction Details		
STANDARD TYPICAL SECTION		
COLLECTOR		
60' R/W 40' PVMT		
Dr. G.P.L.	2000	STR.02
Ch. R.L.B.		Sh 1

CR-1 02.01



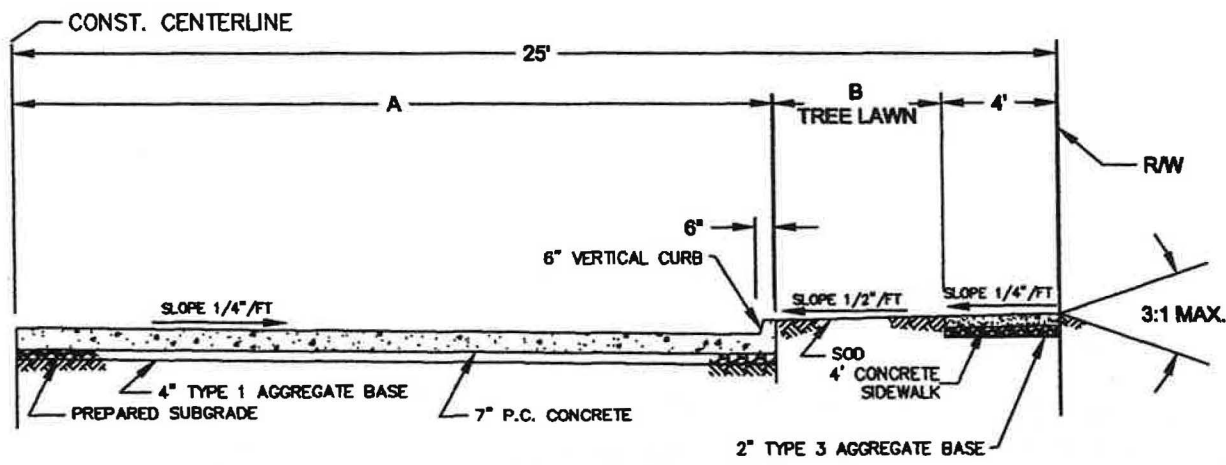
ASPHALT PAVEMENT WITH ROCK BASE

CITY OF PACIFIC, MISSOURI
Standard Construction Details

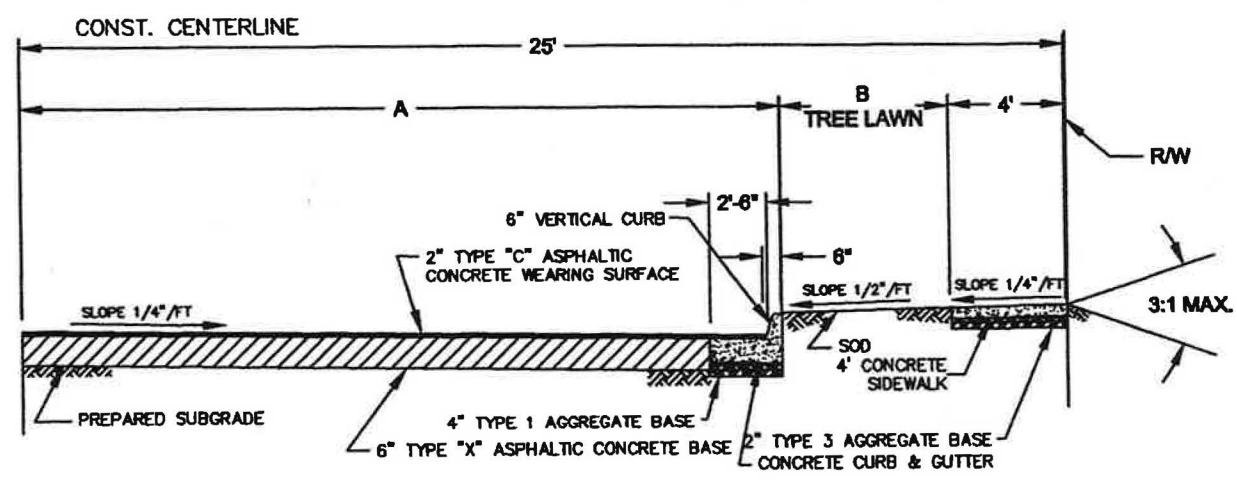
STANDARD TYPICAL SECTION
COLLECTOR
60' R/W 40' PVMT

Dr. G.P.L. Ch.R.L.B.	2000	STR.02 Sh 2
-------------------------	------	----------------

1111111111



RIGID PAVEMENT (CONCRETE)



FULL DEPTH ASPHALT PAVEMENT

GENERAL NOTES:

1. SECTIONS ARE SYMMETRICAL ABOUT CONSTRUCTION CENTERLINE.
2. FOR LONGITUDINAL AND TRANSVERSE JOINTS, DOWEL AND TIE BAR REQUIREMENTS AND CURB DIMENSIONS REFER TO STANDARD DETAILS STR.25, STR.60 & STR.70.
3. ALL NECESSARY PAVEMENT MARKINGS BY THE CITY OF PACIFIC.
4. SIDEWALK THICKNESS IS 4' THRU RESIDENTIAL DRIVEWAYS AND 7" THRU COMMERCIAL DRIVEWAYS. SEE ENTRANCE DETAILS.
5. ADDITIONAL PAVEMENT THICKNESS, REINFORCEMENT AND/OR BASE IS REQUIRED FOR HEAVY VEHICULAR USAGE OR HIGH TRAFFIC VOLUMES.
6. SECTIONS SHOWN MAY NOT APPLY AT INTERSECTIONS.

	A	B
NORMAL	16'	5'
SUBDIVISIONS EXCLUSIVELY FOR SINGLE FAMILY RESIDENCES	15'	6'

CITY OF PACIFIC, MISSOURI
Standard Construction Details

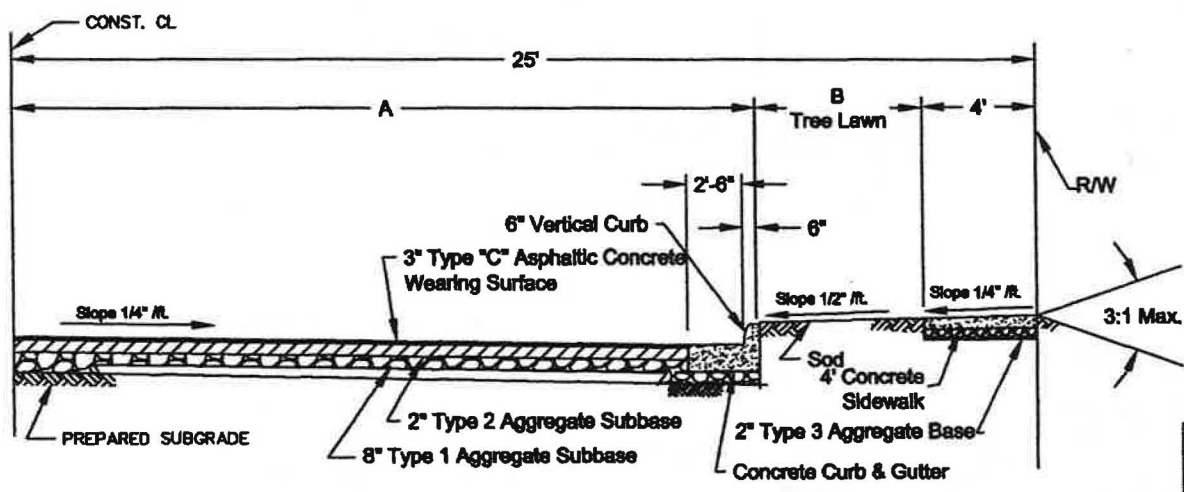
STANDARD TYPICAL SECTION

MINOR
 50' R/W

Dr. G.P.L. Ch. R.L.B.	2000	STR.03 Sh 1
--------------------------	------	----------------

1111111111

JULY 2000

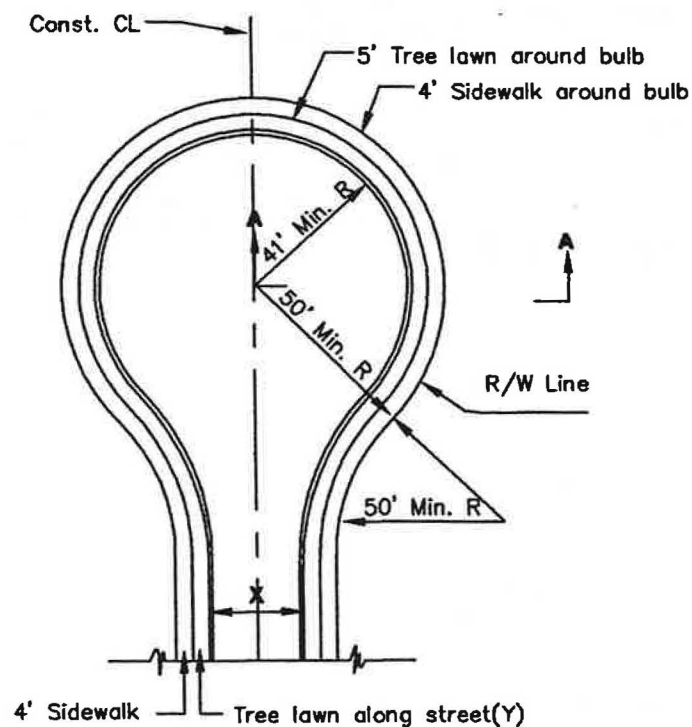


ASPHALT PAVEMENT WITH ROCK BASE

	A	B
NORMAL	16'	5'
SUBDIVISIONS EXCLUSIVELY FOR SINGLE FAMILY RESIDENCES	15'	6'

CITY OF PACIFIC, MISSOURI <i>Standard Construction Details</i>		
STANDARD TYPICAL SECTION MINOR 50' R/W		
Dr. G.P.L. Ch. R.L.B.	2000	STR.03 Sh 2

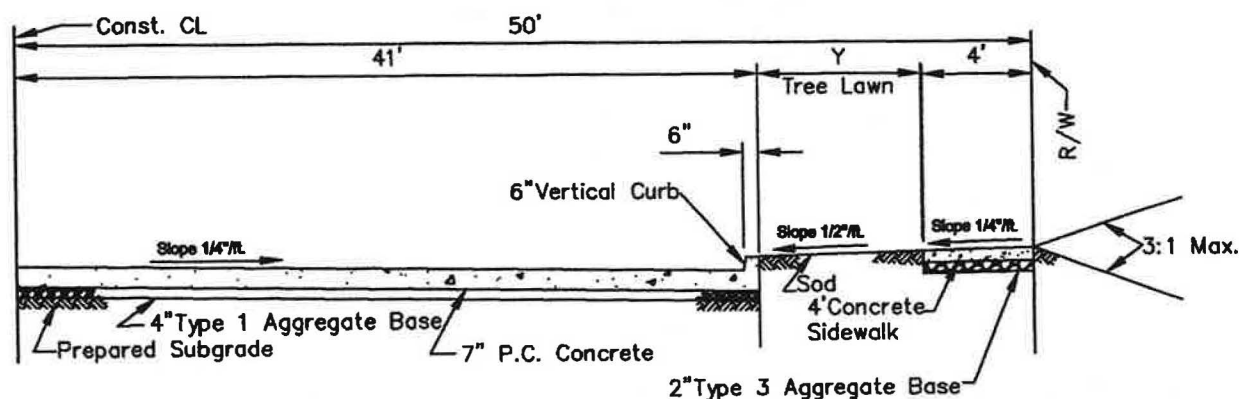
Ch-1.03.02



GENERAL NOTES

1. For longitudinal and transverse joints, dowel and tie bar requirements and curb dimensions not shown refer to STR.25 and Str.70.
2. All necessary pavement markings by City of Pacific.
3. Sidewalk thickness is 4" thru Private Driveways and 7" thru Commercial Driveways.

Street ROW	X	Y
48'	26'	6'
50'	32'	5'

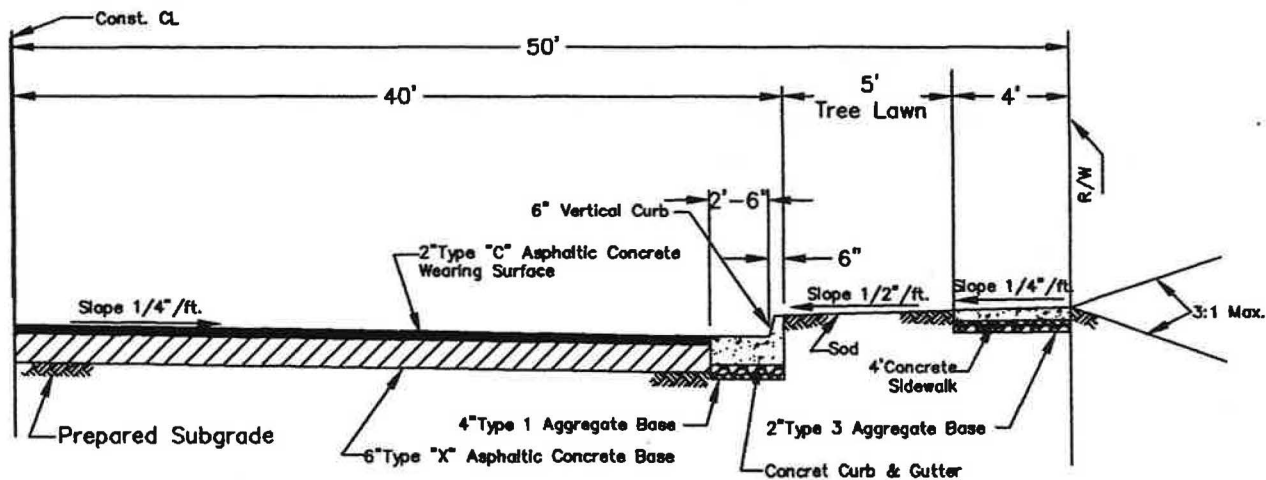


SECTION A-A: RIGID PAVEMENT (CONCRETE)

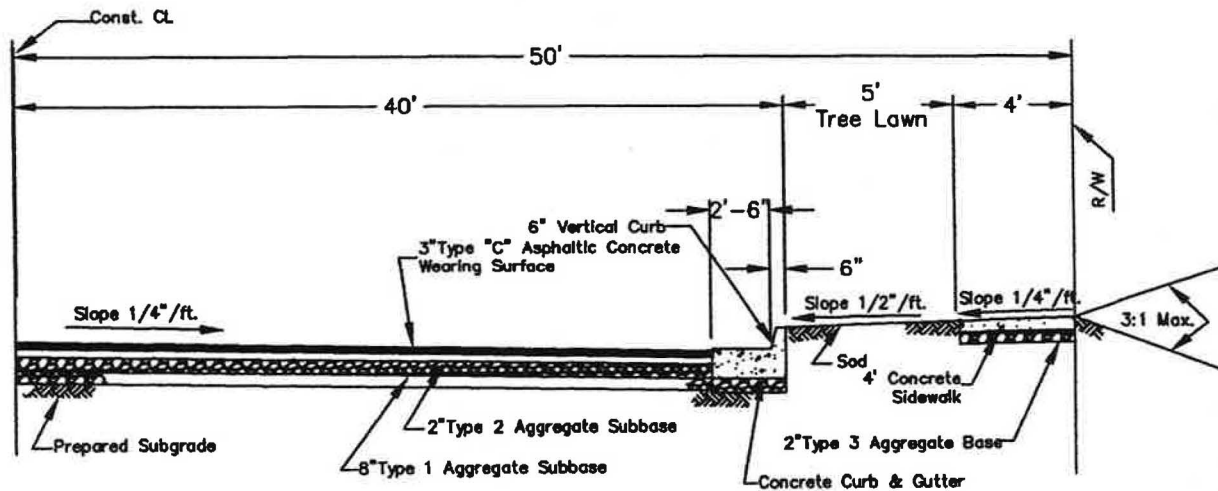
CITY OF PACIFIC, MISSOURI
Standard Construction Details

CUL-DE-SAC DETAIL

Dr. G.P.L. Ch. R.L.B.	2000	STR.12 Sh 1
--------------------------	------	----------------



Section A-A: FULL DEPTH ASPHALT PAVEMENT



Section A-A: ASPHALT PAVEMENT WITH ROCK BASE

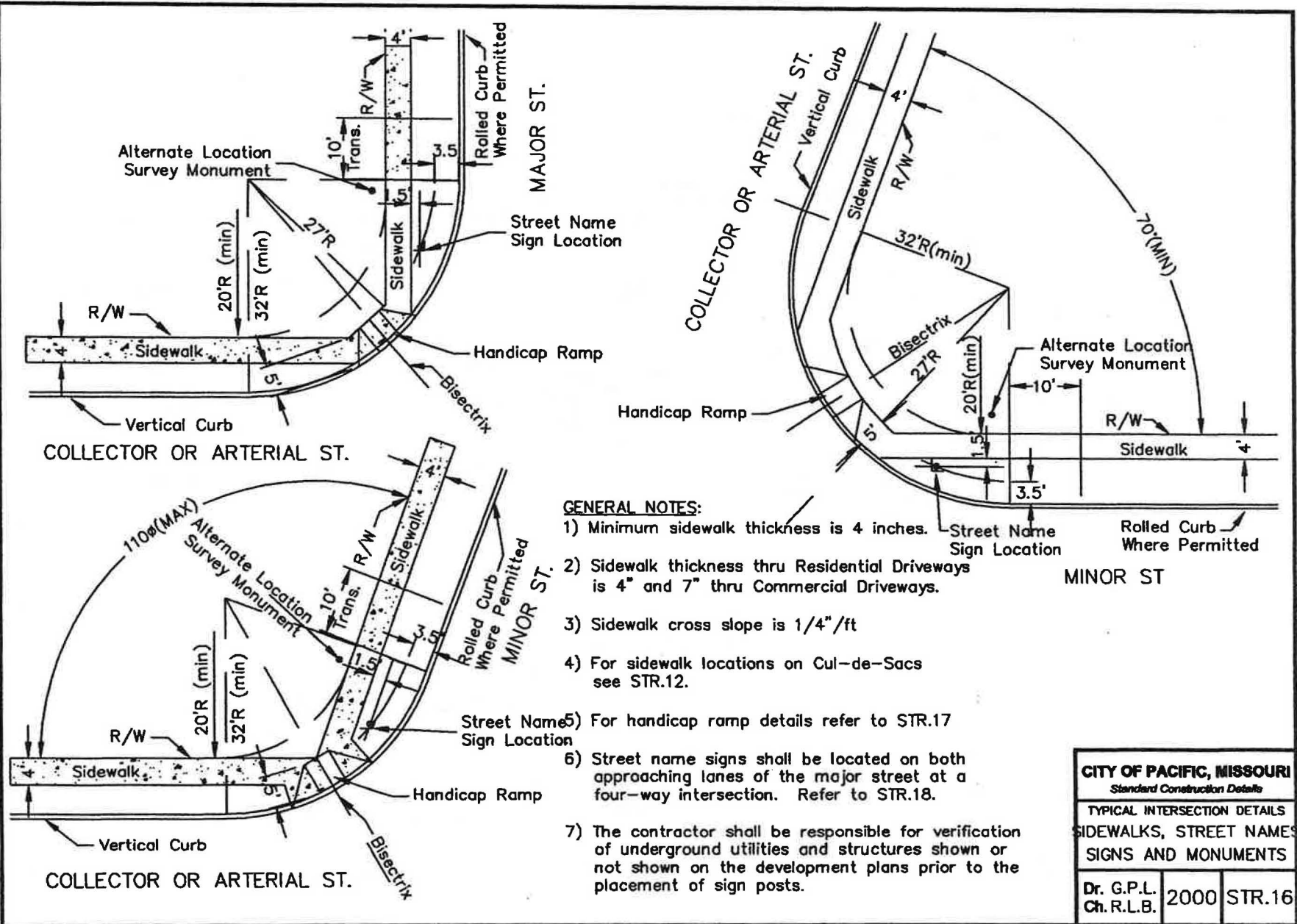
CITY OF PACIFIC, MISSOURI
Standard Construction Details

CUL-DE-SAC
DETAIL

Dr. G.P.L.
Ch. R.L.B.

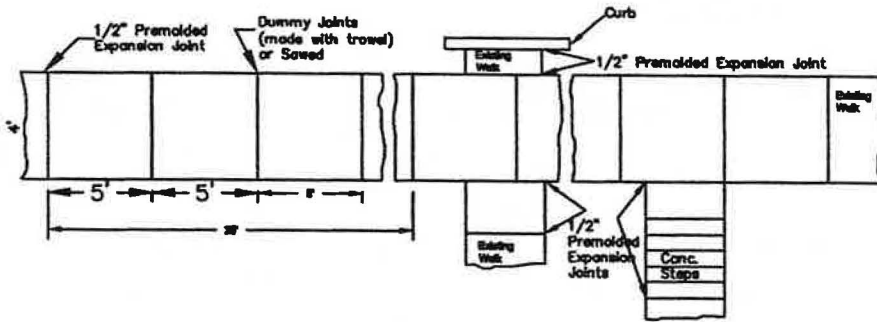
2000

STR.12
Sh 2



- GENERAL NOTES:**
- 1) Minimum sidewalk thickness is 4 inches.
 - 2) Sidewalk thickness thru Residential Driveways is 4" and 7" thru Commercial Driveways.
 - 3) Sidewalk cross slope is 1/4"/ft
 - 4) For sidewalk locations on Cul-de-Sacs see STR.12.
 - 5) For handicap ramp details refer to STR.17
 - 6) Street name signs shall be located on both approaching lanes of the major street at a four-way intersection. Refer to STR.18.
 - 7) The contractor shall be responsible for verification of underground utilities and structures shown or not shown on the development plans prior to the placement of sign posts.

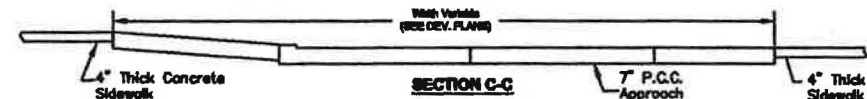
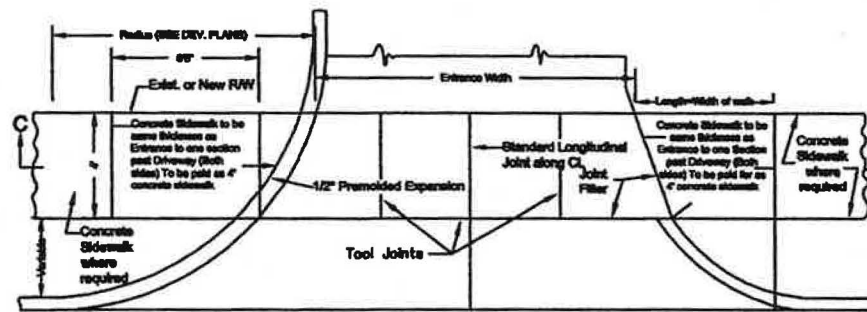
CITY OF PACIFIC, MISSOURI		
<i>Standard Construction Details</i>		
TYPICAL INTERSECTION DETAILS		
SIDEWALKS, STREET NAMES		
SIGNS AND MONUMENTS		
Dr. G.P.L.	2000	STR.16
Ch. R.L.B.		



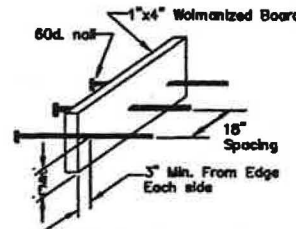
CONCRETE SIDEWALK JOINTS

GENERAL NOTES

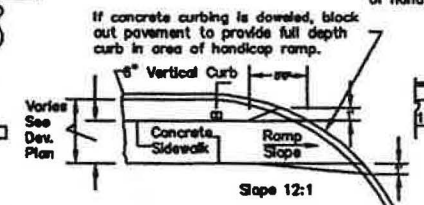
1. Sidewalk cross slope 1/4"/ft.
 2. For sidewalk locations on Out-of-Side STR.12.
 3. For longitudinal and transverse joints, dowel and tie bar requirements and dimensions refer to STR.25 and STR.70.
 4. All necessary pavement markings by City of Pacific.
- For roadway cross slopes, pavement types and thickness refer to STR.01-STR.03.



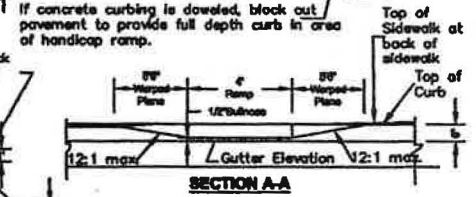
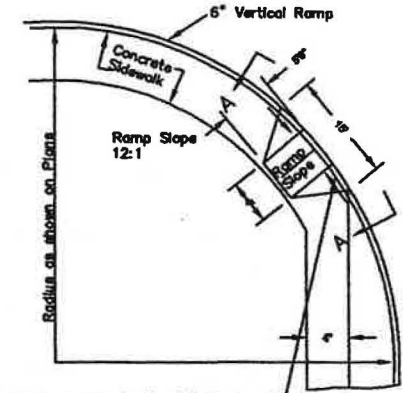
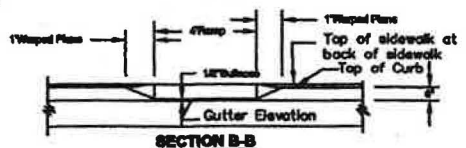
CONCRETE SIDEWALK AND HANDICAP RAMP AT COMMERCIAL ENTRANCE



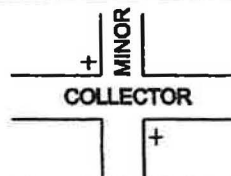
SIDEWALK EXPANSION JOINT



Handicap Ramp

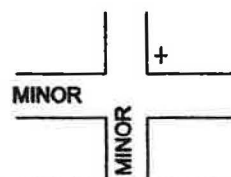


CITY OF PACIFIC, MISSOURI		
Standard Construction Details		
PAVEMENT CONSTRUCTION DETAILS		
CONCRETE SIDEWALK AND HANDICAP RAMPS		
Dr. G.P.L. Ch. R.L.B.	2000	STR.17



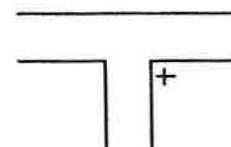
Intersection of a Collector Street with a Minor Street. (Use two (2) sets of signs, both for right indication on Major Street.)

CASE 1



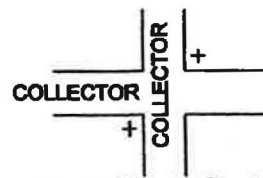
Intersection with two (2) Minor Streets. (Install in North or Northeast Quadrant.)

CASE 2



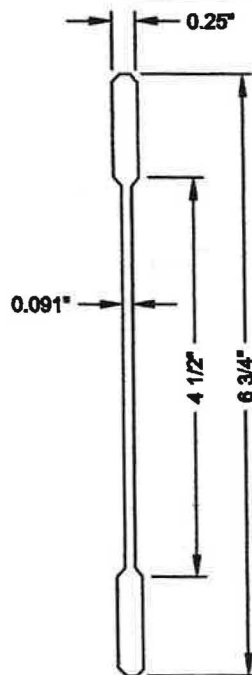
Intersection with "T" intersection. (Install as far right indication on Continuing Street.)

CASE 3



Intersection of two (2) Collector Streets. (Use two (2) sets of signs. Install in North and South or Northeast and Southwest Quadrants.)

CASE 4



CROSS SECTION SIGN BLADE



GENERAL NOTES:

1. Street Name sign plates shall be 6 3/4 inches wide extruded aluminum panels in 24, 30, 36 and 42 inch lengths per drawing shown in this exhibit.
2. Sign Legend shall be 4 inch Series C Reflective White lettering for the Street Name and 2 1/2 inch Series B letters for the suffix and block number on Green Reflective background. All Reflective sheeting shall be Type II-Enclosed Lens and meet Federal Specification FP-79, 1979 Section 633.06 Sheet Reflective materials.
3. Sign Posts shall have a 2 3/8 inch outside diameter and be 11 feet in length. They shall be either Schedule 40 Aluminum Pipe or galvanized Steel with a wall thickness of 0.065 inches. The inside wall shall be galvanized or have a full zinc based organic coating in accordance with ASTM-A513 to obtain a weight of 0.90 oz. per sq. ft. commercial zinc weight (G-90).
4. Signs are to be mounted a minimum of 3.5 feet from the back of curb with a minimum clearance from the sidewalk of 1.5 feet.
5. Additional information relating to fabrication, field testings and quality of street name signs, connectors and posts is on file at Pacific City Hall.
6. Sign Posts shall be mounted 18-24 inches in the ground and set in a concrete base.
7. For additional information refer to the Typical Intersection Details for "Sidewalks, Street Name Signs and Monument," Standard Drawing.
8. The contractor shall be responsible for verification of underground utilities and structures shown or not shown prior to the placement of sign posts.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

STREET NAME SIGNS,
DETAILS AND LOCATIONS

Dr. G.P.L. Ch. R.L.B.	2000	STR.18
--------------------------	------	--------

"W"= Total number of through and left turn lanes approaching intersection from the left.

"X"= Sight distance to the left. (Measured along driving path)

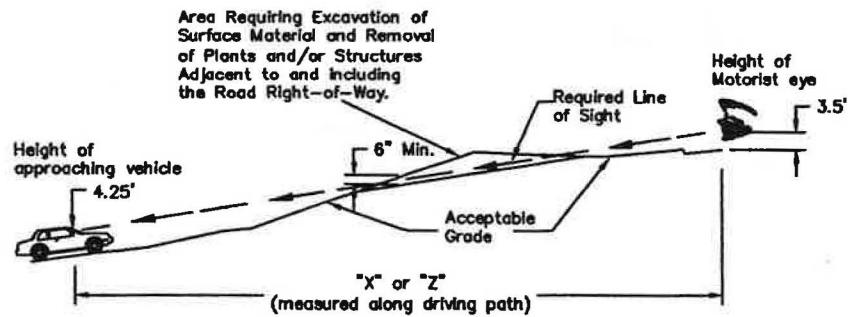
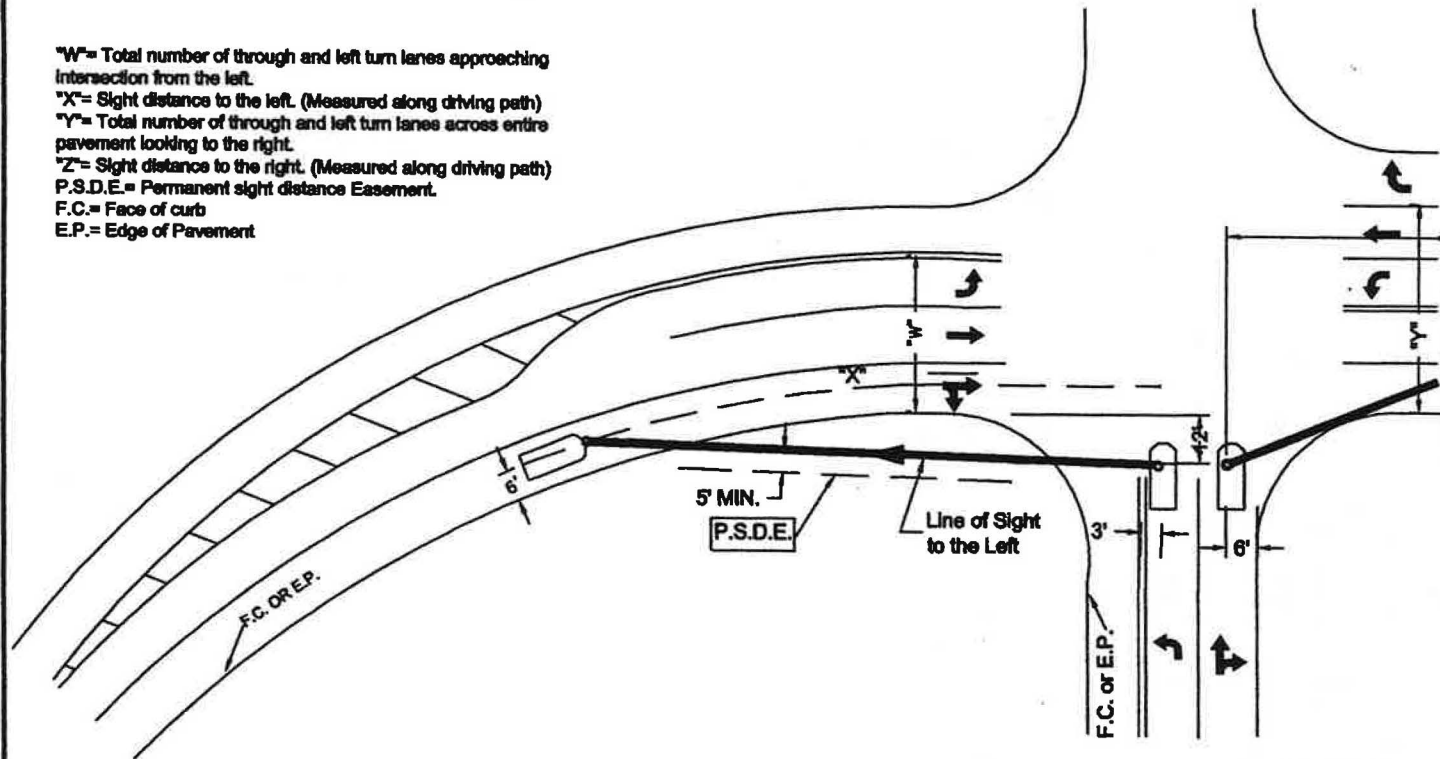
"Y"= Total number of through and left turn lanes across entire pavement looking to the right.

"Z"= Sight distance to the right. (Measured along driving path)

P.S.D.E.= Permanent sight distance Easement.

F.C.= Face of curb

E.P.= Edge of Pavement



TYPICAL PROFILE ALONG LINE OF SIGHT TO THE LEFT

CITY OF PACIFIC, MISSOURI
Standard Construction Details

**SIGHT DISTANCE
AT INTERSECTION**

Dr. G.P.L. Ch. R.L.B.	2000	STR.19 Sh 1
--------------------------	------	----------------

SIGHT DISTANCE FOR VEHICLE ENTERING ROADWAY FROM STOPPED POSITION ASSOCIATED WITH NEW DEVELOPMENT

Design Speed on Thru Roadway (MPH)	Sight Distance to the Right ("Z")				Sight Distance to the Left ("X")		
	"Y"=2 Lanes	"Y"=3 Lanes	"Y"=4 Lanes	"Y"=5 Lanes	"W"=1 Lanes	"W"=2 Lanes	"W"=3 Lanes
15	155'	165'	180'	190'	155'	155'	165'
20	210'	225'	135'	250'	155'	210'	225'
25	260'	280'	295'	315'	155'	260'	280'
30	310'	335'	355'	375'	155'	310'	335'
35	360'	390'	415'	440'	155'	360'	390'
40	415'	445'	470'	500'	155'	415'	445'
45	465'	500'	530'	555'	155'	465'	500'
50	515'	555'	590'	610'	155'	515'	555'
55	570'	610'	650'	670'	155'	570'	610'
60	620'	665'	710'	720'	155'	620'	665'
65	670'	720'	765'	775'	155'	670'	720'
70	720'	775'	825'	825'	155'	720'	775'

"W" = Total number of through and left turn lanes approaching intersection from the left.

"X" = Sight distance to the left. (measured along driving path)

"Y" = Total number of through and left turn lanes across entire pavement looking to the right.

"Z" = Sight distance to the right. (measured along driving path)

[P.S.D.E.] = Permanent Sight Distance Easement

F.C. = Face of Curb

E.P. = Edge of Pavement

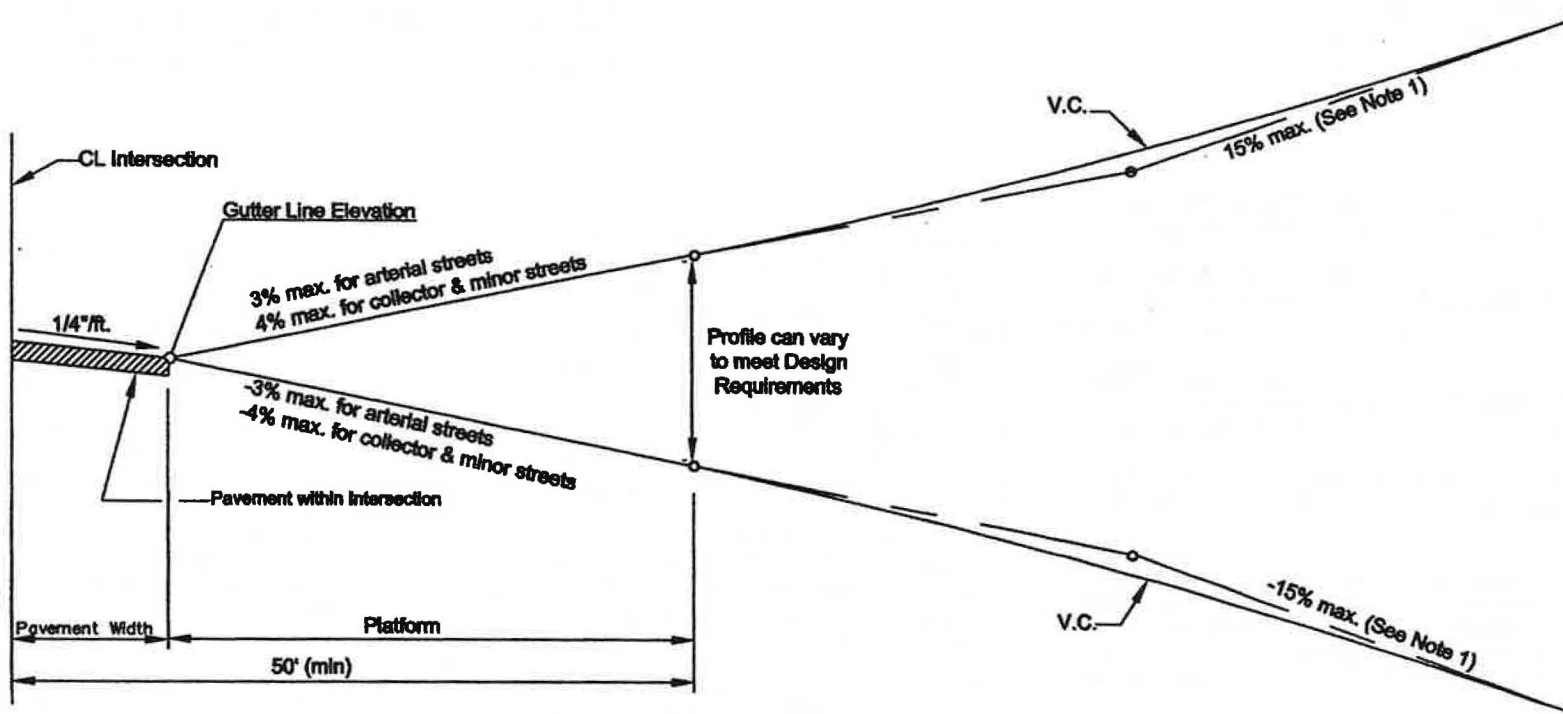
GENERAL NOTES

1. Sight distance design criteria shall be based upon ultimate number of lanes.
2. On existing roadways the design speed shall be the 85th percentile speed of motorist on the roadway as established by radar studies or 5 m.p.h. greater than the posted speed limit, whichever is greater. For residential and non-residential streets with a pavement width of 32 ft. or less the design speed shall be the anticipated posted speed limit.
3. On new roadways the design speed shall be 5 m.p.h. greater than the anticipated posted speed limited. For residential and nonresidential streets with a pavement width of 32 ft. or less the design speed shall be the anticipated posted speed limited.
4. At a tee intersection, line of sight to the right shall be measured from a vehicle in the left turn lane.
5. If "W" is greater than 3 lanes or "Y" is greater than 5 lanes, sight distance data shall be increased by extrapolating from values shown on the chart.
6. If "W" or "Y" include a median, sight distance data shall be increased by interpolating or extrapolating from values shown on the chart.
7. Height of motorist eye in stopped vehicle = 3.50 ft.
Height of approaching vehicle = 4.25 ft.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

SIGHT DISTANCE AT INTERSECTION

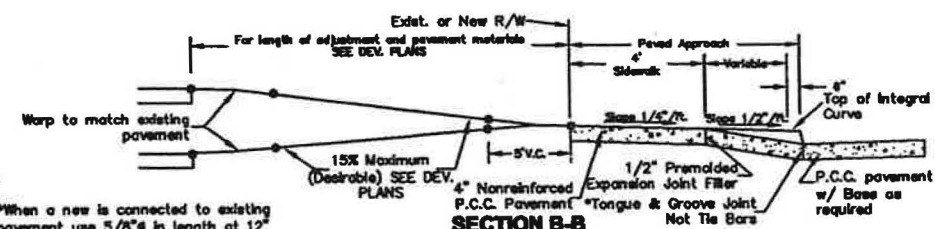
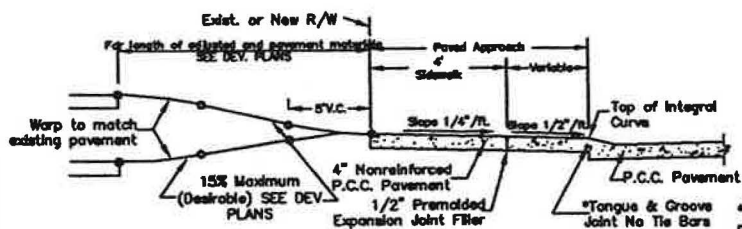
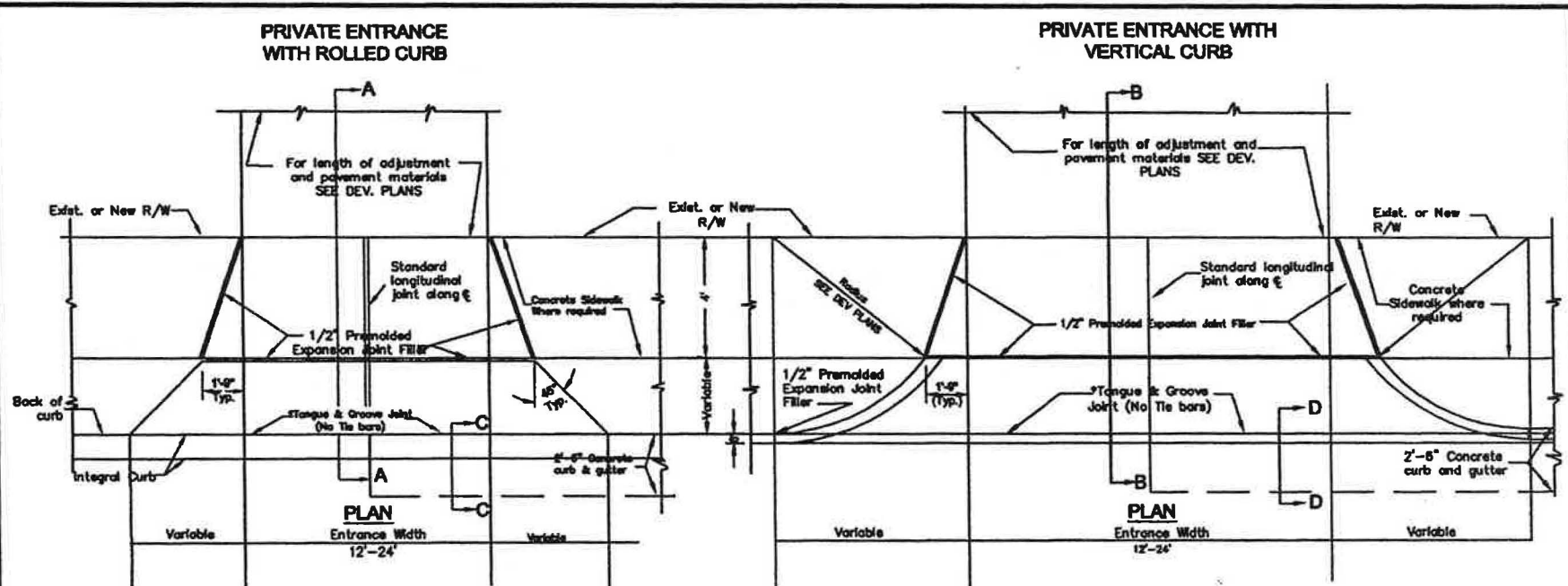
Dr. G.P.L. Ch. R.L.B.	2000	STR.19 Sh 2
--------------------------	------	----------------



GENERAL NOTES

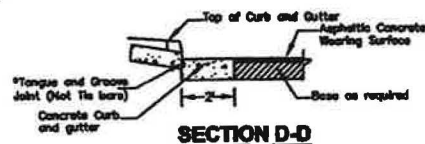
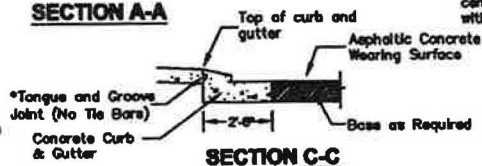
- 1. May be varied with Steep Grade Approval if recommended by the Commissioner and approved by the Board of Aldermen.**
- 2. See STR.40 for Vertical Curve Design.**

CITY OF PACIFIC, MISSOURI <i>Standard Construction Details</i>		
ENTRANCE CONSTRUCTION DETAILS STREET INTERSECTION PLATFORM		
Dr. G.P.L. Ch. R.L.B.	2000	STR.20

**GENERAL NOTES**

1. All 1/2" premolded expansion joints shall extend from subgrade to 1/2" below top of finished surface of concrete. The upper 1/2" shall be open and edges of new concrete shall be rounded to 1/4" radii.

2. Curb and joint dimensions as shown in STR.25 & STR.70.



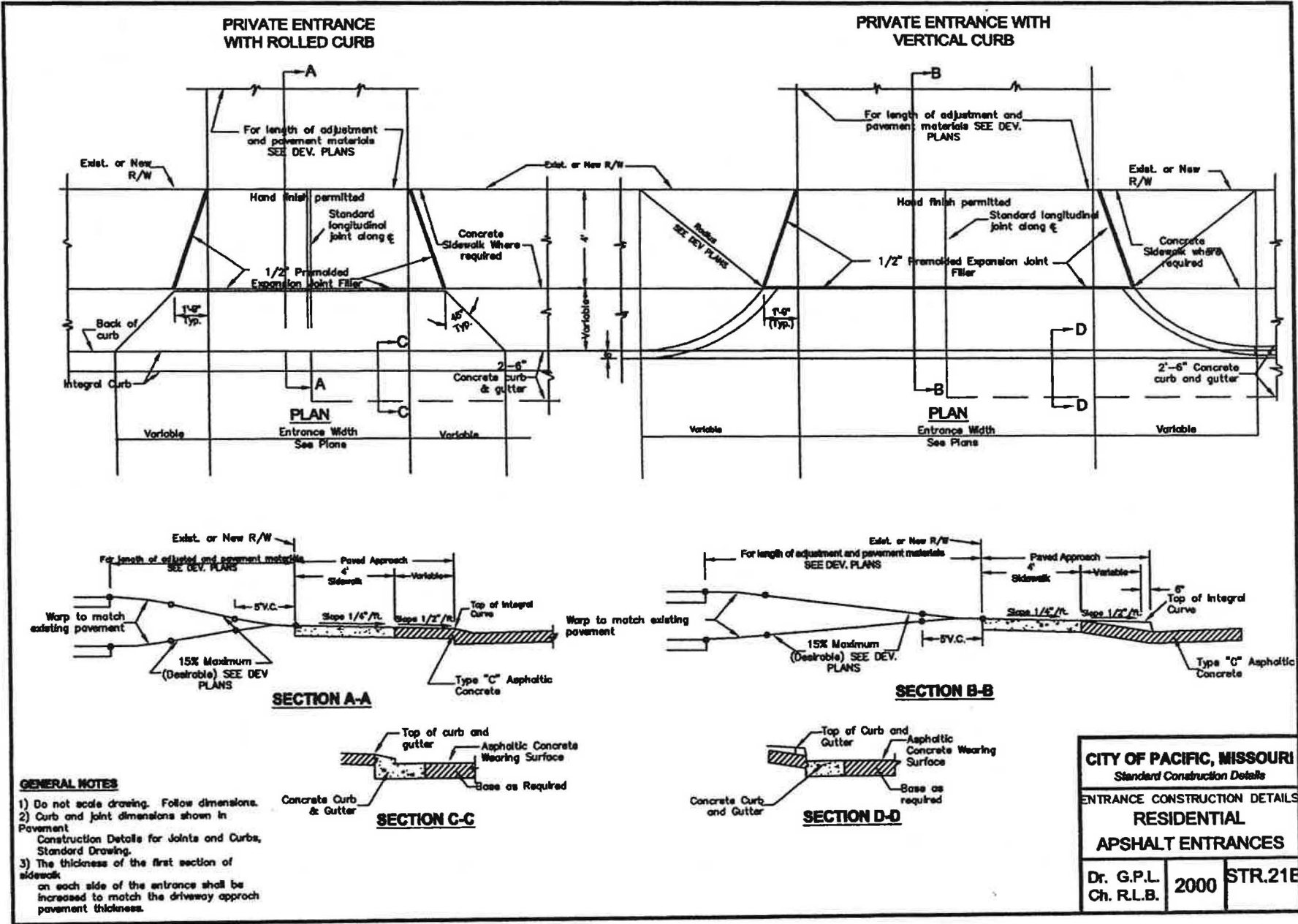
CITY OF PACIFIC, MISSOURI
Standard Construction Details

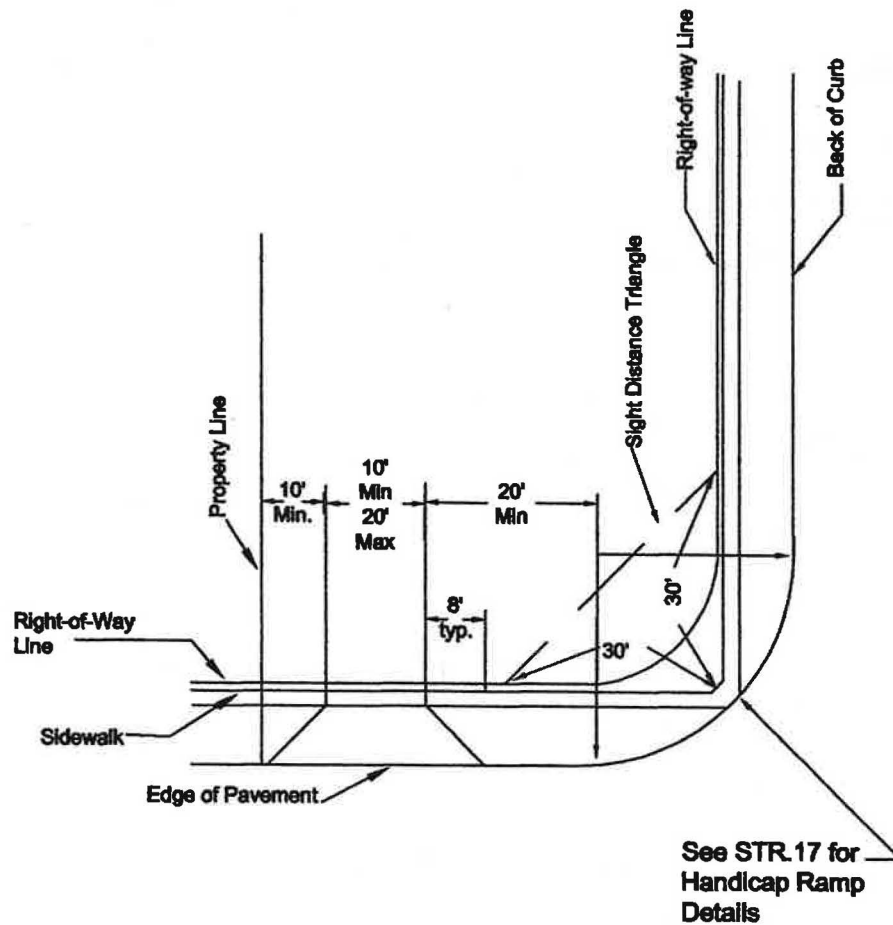
ENTRANCE CONSTRUCTION DETAILS
RESIDENTIAL
CONCRETE ENTRANCES

Dr. G.P.L. 2000 STR.21A
Ch. R.L.B.

JULY 2000

Ch-1.21B

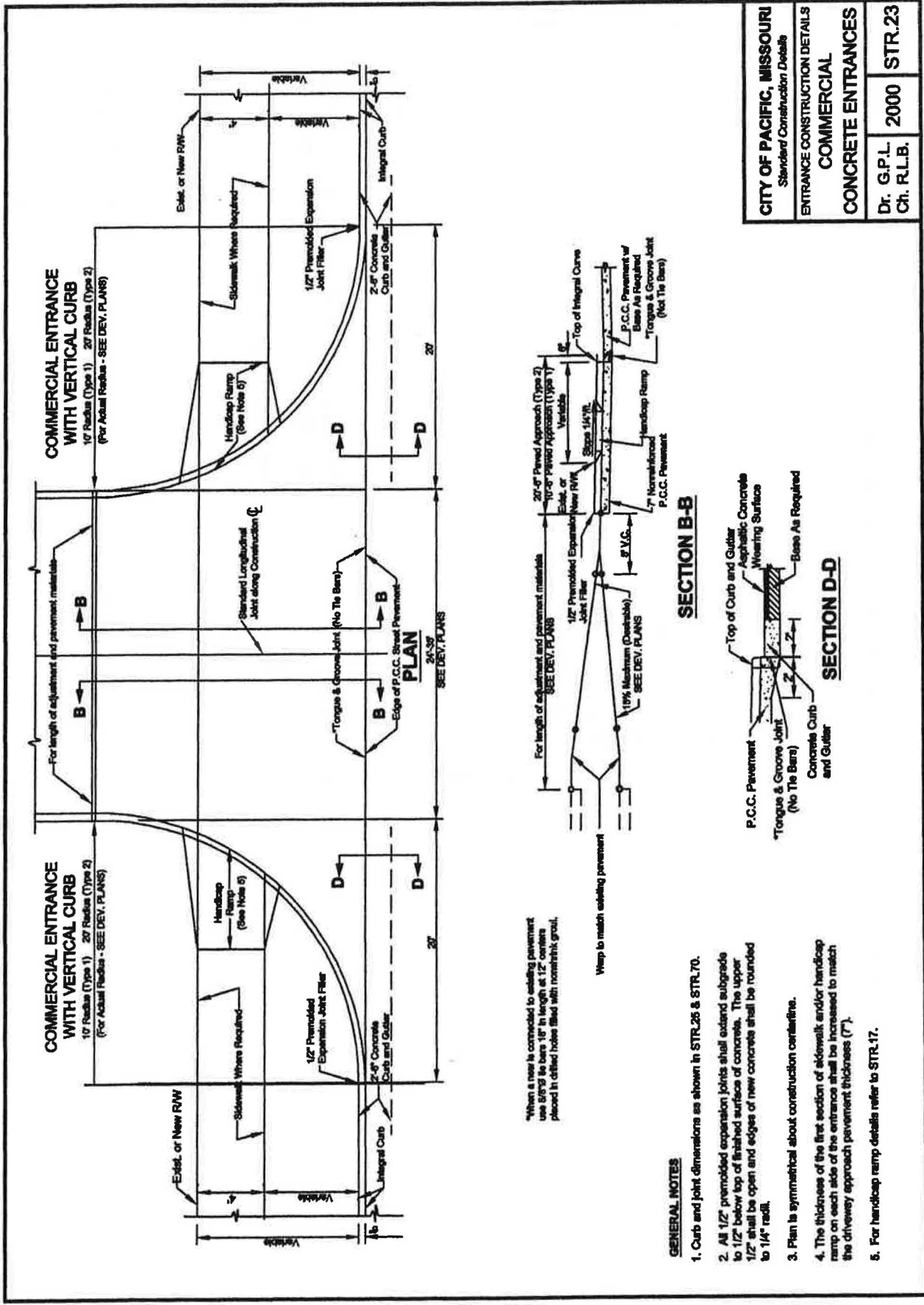




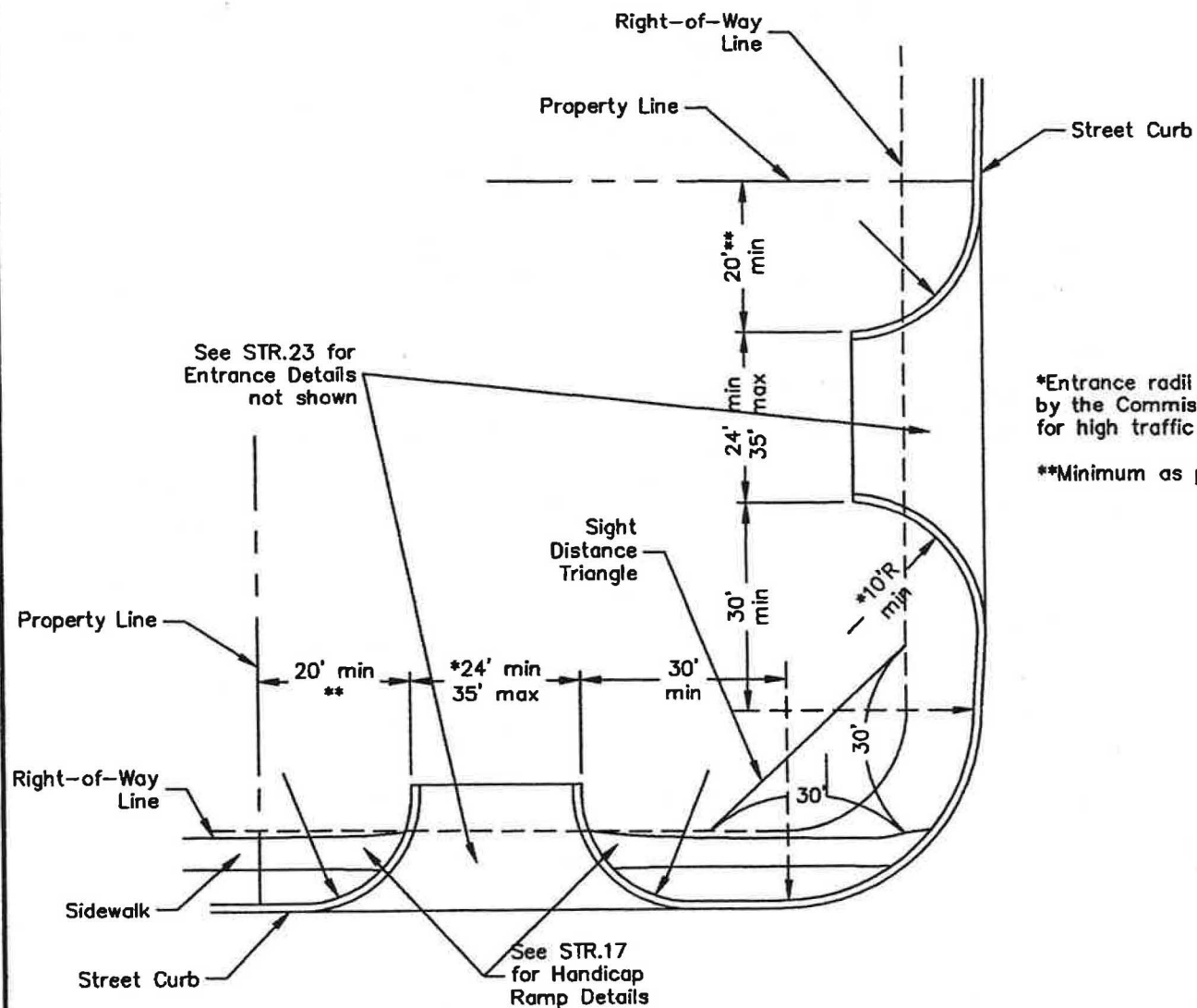
***May be varied to conform to type of entrance construction in approved subdivisions.**

****Minimum as prescribed by zoning district.**

CITY OF PACIFIC, MISSOURI		
Standard Construction Details		
ENTRANCE CONSTRUCTION DETAILS		
RESIDENTIAL		
ENTRANCE CLEARANCE		
Dr. G.P.L. Ch. R.L.B.	2000	STR.22



CITY OF PACIFIC, MISSOURI	
Standard Construction Details	
ENTRANCE CONSTRUCTION DETAILS	
COMMERCIAL	
CONCRETE ENTRANCES	
Dr. G.P.L.	2000
Ch. R.L.B.	STR.23



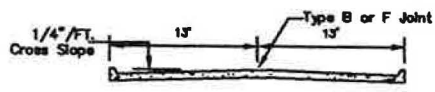
*Entrance radii may be increased as determined by the Commissioner of Public Works to provide for high traffic volumes or movement of large trucks.

**Minimum as prescribed by zoning district.

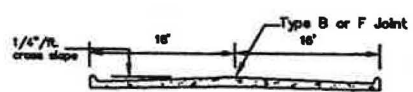
CITY OF PACIFIC, MISSOURI
Standard Construction Details

ENTRANCE CONSTRUCTION DETAILS
COMMERCIAL
ENTRANCE CLEARANCE

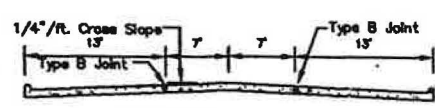
Dr. G.P.L. Ch. R.L.B.	2000	STR.24
--------------------------	------	--------



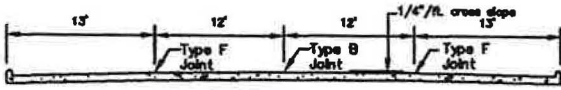
SECTION-26' WIDTH



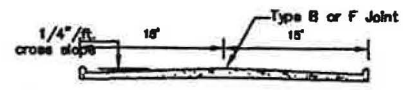
SECTION-32' WIDTH



SECTION-40' WIDTH

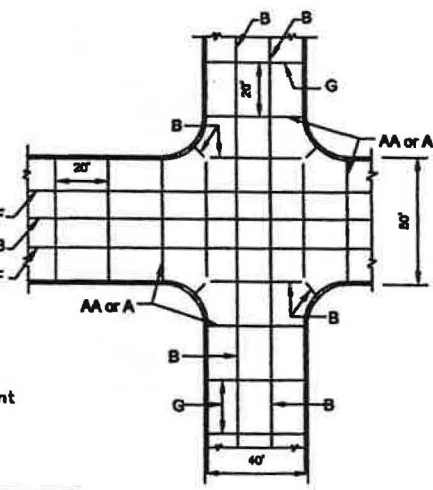
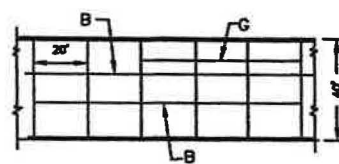
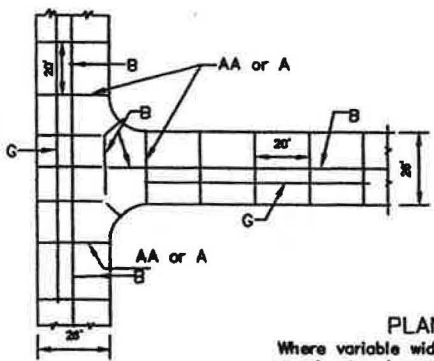


SECTION-50' WIDTH



SECTION-30' WIDTH

Note
All joints shall be sealed
per Section 3.4.17.



PLAN OF JOINT LOCATION

Where variable width of intersecting pavements are shown joint spacing must conform to locations indicated on Approved Construction Plans.

GENERAL NOTES

1. Do not scale drawing. Follow dimensions.
2. All street inlets shall be separated from the pavement and curb by expansion joint material extending completely through curb and slab.
3. When a joint falls within 5' of, or contacts inlets, manholes, or other structures, shorten one or more panels either side of opening to permit joint to fall on round structures and at or between corners of rectangular structures.
4. Driveway configurations are shown in the Entrance Details.
5. See Standard Details STR.01-STR.03 for typical pavement sections.
6. Refer to Pavement Construction Details "Joints and Curbs" for joint and bar requirements. Note that width and location of each poured portion of the pavement may change the type and location of joint required. See Standard Drawing STR.70.
7. Transverse or longitudinal construction joints in slip formed pavements may be made with a groover or tool, if such device has been approved in advance by the Department.
8. The locations of the Type B and Type F longitudinal construction joints in the sections may be interchanged for the different widths of construction if approved by the Department.
9. Details for rolled curb (where permitted) are similar.

JOINT REQUIREMENTS FOR CONCRETE PAVEMENT

STREET	JOINT TYPE	JOINT AND BAR REQUIREMENTS
All Arterial, County, Non-Residential or residential Major Collector 25'-50' Wide Pavement 7"-8" Thick concrete	Transverse	TYPE G 1" smooth dowel bars 18"lg. @ 12" ctr.
	Longitudinal	Within a poured section: At the edge between two poured sections: Type F 5/8" deformed tie bars 30" lg. @ 30" ctr. 5/8" deformed tie bars 30" lg. @ 30" ctr.
	Expansion	TYPE AA 1" smooth dowel bars 18"lg. @ 12" ctr.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

INTEGRAL VERTICAL CURB
AND CONCRETE PAVEMENT
TYPICAL SECTION AND DETAIL

Dr. G.P.L. 2000 STR.25
Ch. R.L.B.

Design Speed (M.P.H.)	"K" VALUES FOR CREST AND SAG VERTICAL CURVES								Minimum Value of "K"
	2 Lane Pavement		3 Lane Pavement		4 Lane Pavement		5 Lane Pavement		
	Crest	Sag	Crest	Sag	Crest	Sag	Crest	Sag	
15	10	10	10	10	15	10	15	10	50'
20	20	20	20	20	20	20	25	20	60'
25	25	25	30	30	35	30	35	30	75'
30	35	35	40	40	45	40	55	40	90'
35	50	50	55	50	65	50	70	50	105'
40	80	70	80	70	80	70	90	70	120'
45	120	90	120	90	120	90	120	90	135'
50	160	110	160	110	160	110	160	110	160'
55	220	130	220	130	220	130	220	130	165'
60	310	160	310	160	310	160	310	160	180'
65	400	180	400	180	400	180	400	180	195'
70	540	220	540	220	540	220	540	220	210'

FORMULAS: $K=L+A$ OR $L=KA$

EXAMPLE 1: 4 Lane Pavt., Design Speed=35m.p.h.
Crest Vertical Curve where $A=6.0$
 $L=65 \times 6.0=390'$

EXAMPLE 2: 2 Lane Pavt., Design Speed=25m.p.h.
Crest Vertical Curve where $A=2.5$
 $L=25 \times 2.5=62.5$ -Use minimum "L" as
shown in right column, $L=75'$

EXAMPLE 3: 3 Lane Pavt., Design Speed=45m.p.h.
Sag Vertical Curve where $A=3.0$
 $L=90 \times 3.0=270'$

CAUTION!

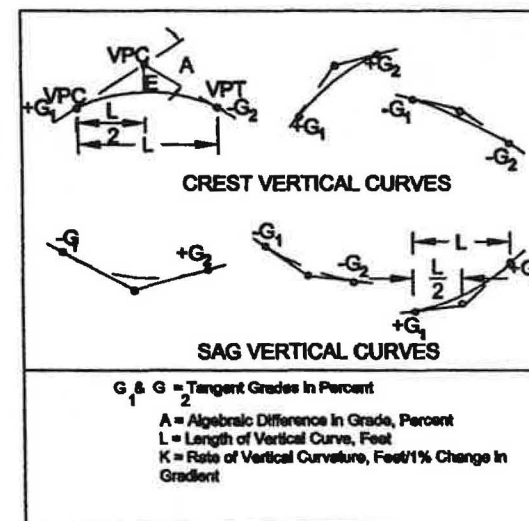
Special attention to drainage must be
exercised where a "K" Value greater than
160 is used.

GENERAL NOTES

1. On existing roadways, the design speed shall be the 85th
percentile speed of motorists on the roadway as established by
radar studies, or 5m.p.h. greater than the posted speed limit,
whichever is greater. For residential and nonresidential streets
with a pavement width of 32ft. or less, the design speed shall be
the anticipated posted speed limit.

2. On new roadways, the design speed shall be 5m.p.h. greater
than the anticipated posted speed limit. For residential and
nonresidential streets with a pavement width of 32 ft. or less, the
design speed shall be the anticipated posted speed limit.

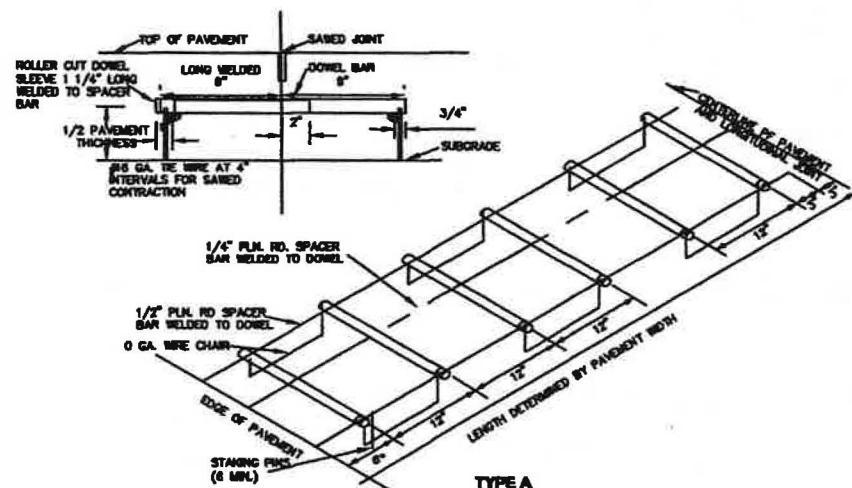
3. Ultimate Pavement Width shall be used to determine the "K"
Values.



CITY OF PACIFIC, MISSOURI
Standard Construction Details

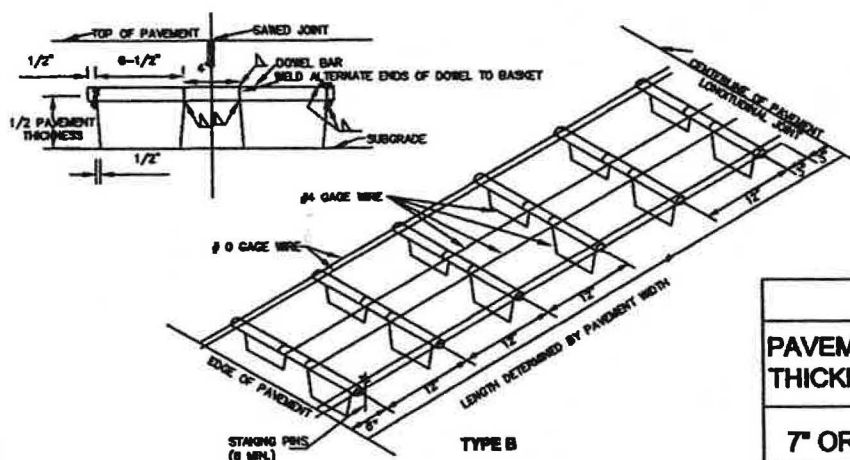
**RECOMMENDED
DESIGN CONTROL
FOR VERTICAL CURVES**

Dr. G.P.L. 2000 STR.40
Ch. R.L.B.



GENERAL NOTES

1. The dowel supporting unit shall be factory assembled and capable of holding the dowels in their required positions. In the completed joint installation, no dowels shall vary from it's required position more than 1 in 36.
2. The dowel bar spacing shall be 12 inches on center, beginning 6" from outer edge of the pavement.
3. Tie wires, bars, or clips used to strengthen dowel basket assemblies for shipment and installation shall be removed or cut prior to placing concrete.
4. Staking pins shall be fabricated from 1/0 ga. (0.3065) wire minimum with a suitable hook. Staking pins shall have a length of 18 inches Type A and Type B Assemblies unless otherwise directed by the engineer.
5. Wires, bars, or clips shall be used as necessary to strengthen the assemblies.
6. Minor variations in the configuration of the support units will be allowed.
7. The wire end of each epoxy coated dowel shall be marked with a spot or point at least one inch in diameter and contrasting in color with the epoxy coating.



DOWEL BARS		
PAVEMENT THICKNESS	BAR SIZE	
	DIAMETER	LENGTH
7" OR 8"	1"	18"

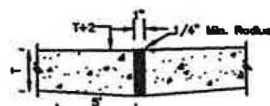
CITY OF PACIFIC, MISSOURI
Standard Construction Details

PAVEMENT CONSTRUCTION DETAILS
DOWEL SUPPORTING UNITS
APPROVED FOR USE WITH
TRAVERSE JOINTS

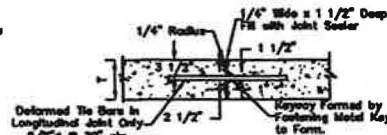
Dr. G.P.L.
Ch. R.L.B.

2000

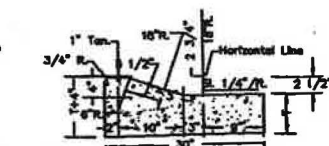
STR.60



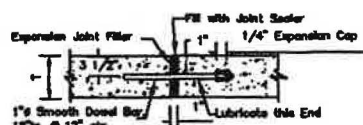
TYPE A
EXPANSION JOINT



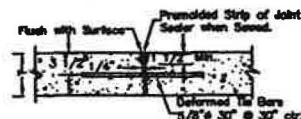
TYPE E
TIED TRANSVERSE
CONSTRUCTION JOINT
(To be Used at Point Not on 20' Joint Spacing)



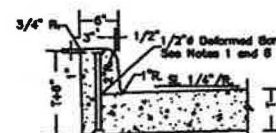
INTEGRAL ROLLED CURB



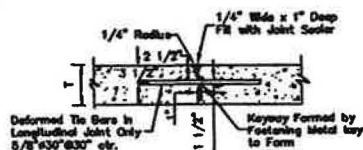
TYPE AA
ALTERNATE EXPANSION JOINT



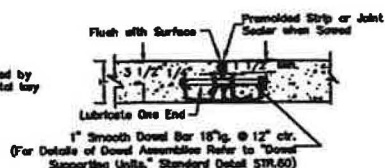
TYPE F
SAWED OR PREMOLDED STRIP
LONGITUDINAL CONSTRUCTION JOINT



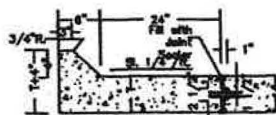
INTEGRAL VERTICAL CURVE



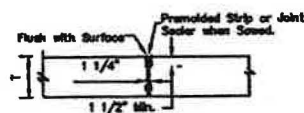
TYPE B
LONGITUDINAL
CONSTRUCTION JOINT
See Note 5



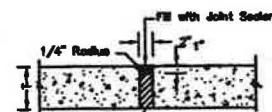
TYPE G
SAWED OR PREMOLDED STRIP
TRANSVERSE CONSTRUCTION JOINT



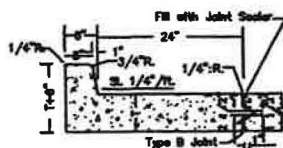
ROLLED CURB AND GUTTER
(30" WIDE)



TYPE C
SAWED OR PREMOLDED STRIP
TRANSVERSE OR LONGITUDINAL
CONSTRUCTION JOINT



TYPE A2
EXPANSION JOINT



VERTICAL CURB AND GUTTER
(30" WIDE)

GENERAL NOTES

1. Construction joint and tie bars may be omitted when curb is poured integral with pavement.
2. See STR.01-STR.03 for pavement thickness.
3. Type "G" Transverse Joint is required for Arterial and Collector Streets. Use Type "C" Transverse Joint for all others.
4. Refer to STR.25 for joint and bar requirements for different street classifications. Note that width and location of each poured portion of the pavement may change the type and location of joint required.
5. All deformed bars for joints and curbs shall be Billet Steel Bars conformed to A.S.T.M. 615-75, Grade 40.
6. Length of the bars shall equal the thickness of pavement plus the height of curb less 3". Tie bars shall be placed at 24" centers.
7. Transverse or longitudinal construction joints in slip formed pavements may be made with a groover of tool if such device has been approved in advance by the Department.
8. For dowel supporting units, refer to STR.60.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

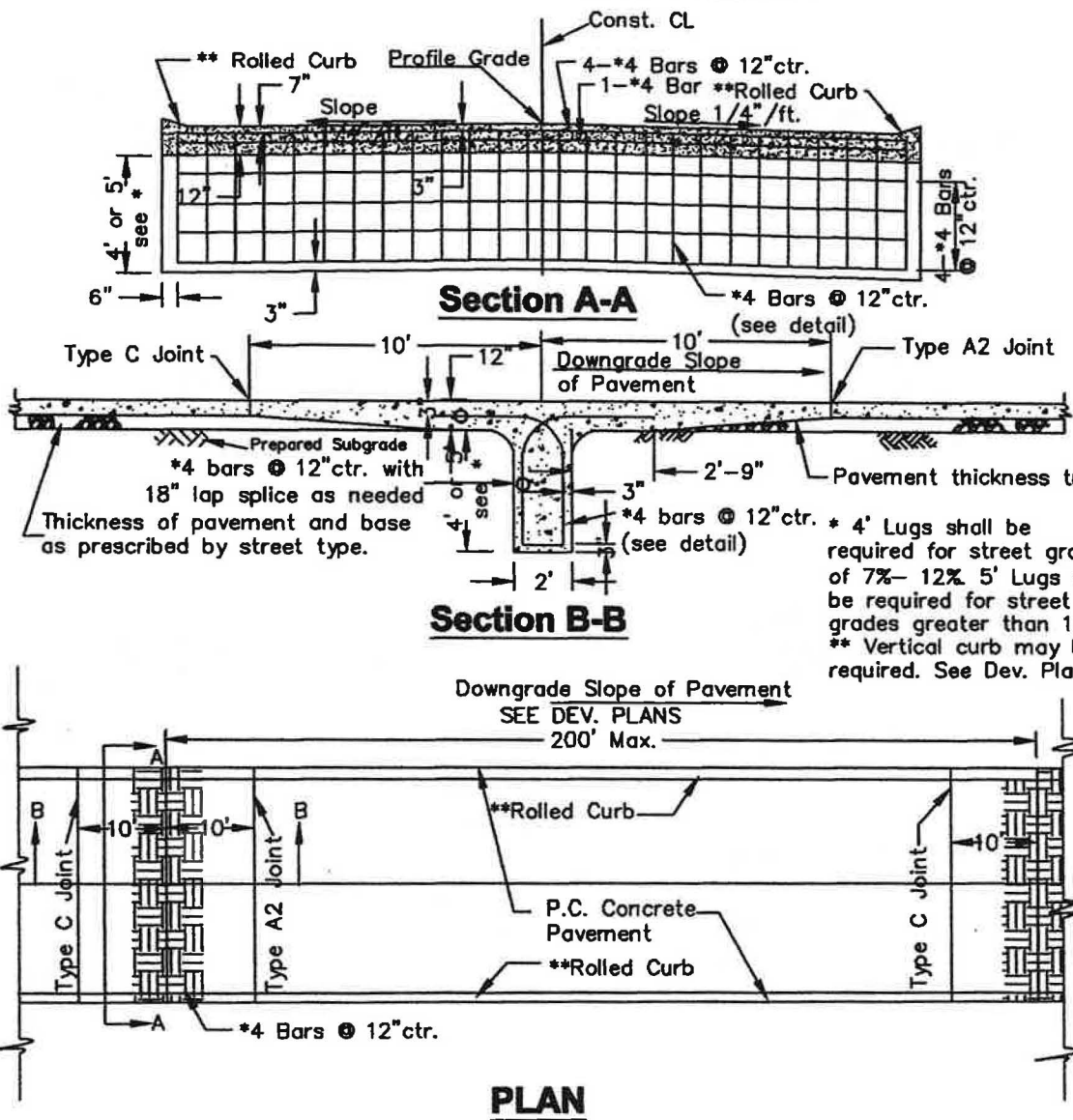
PAVEMENT CONSTRUCTION DETAILS

JOINTS AND CURBS

Dr. G.P.L. Ch. R.L.B.	2000	STR.70
--------------------------	------	--------

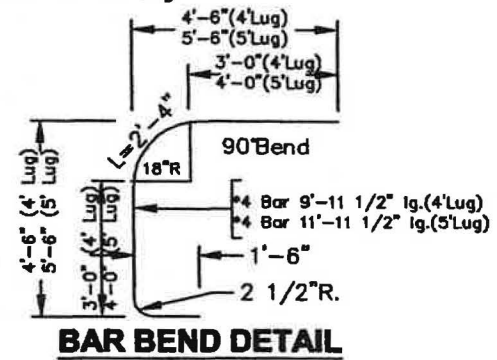
JULY 2000

Ch-1.75.01



GENERAL NOTES:

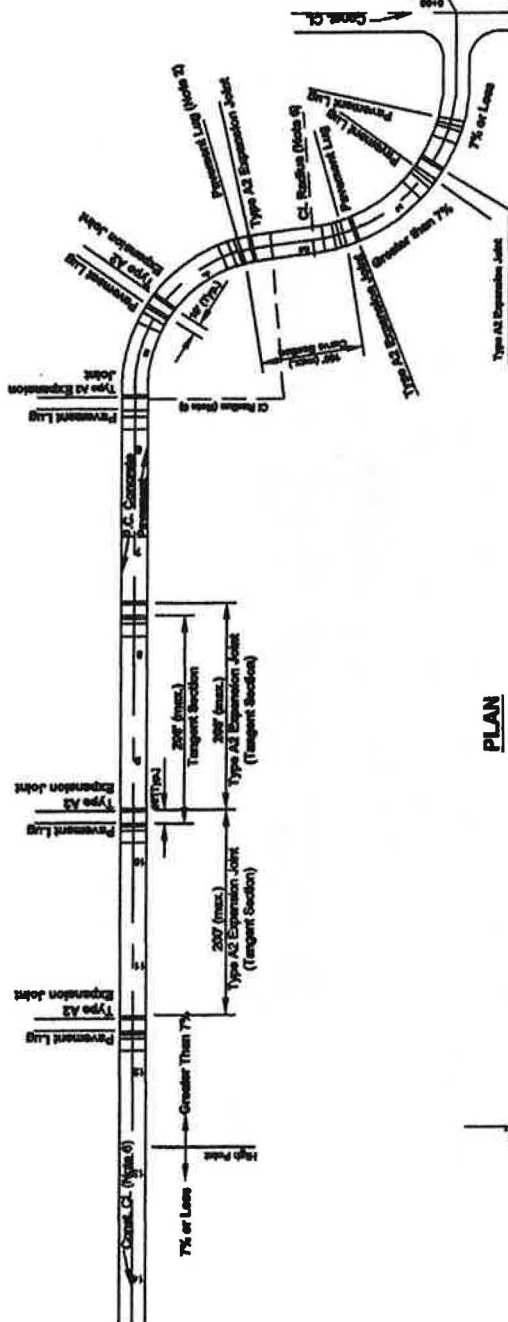
1. Do not scale drawing. Follow dimensions.
2. For longitudinal and transverse joints, dowel and tie bar requirements and curb dimensions refer to Standard Drawings STR.25 and STR.70.
3. Pavement Lugs shall be required on all street grades of 7% or greater.
4. Pavement Lugs shall be located at or near the point at which the street grade first exceeds 7% and then proceed uphill at the following spacing: 200' intervals on tangent sections; or as otherwise directed by the Department.



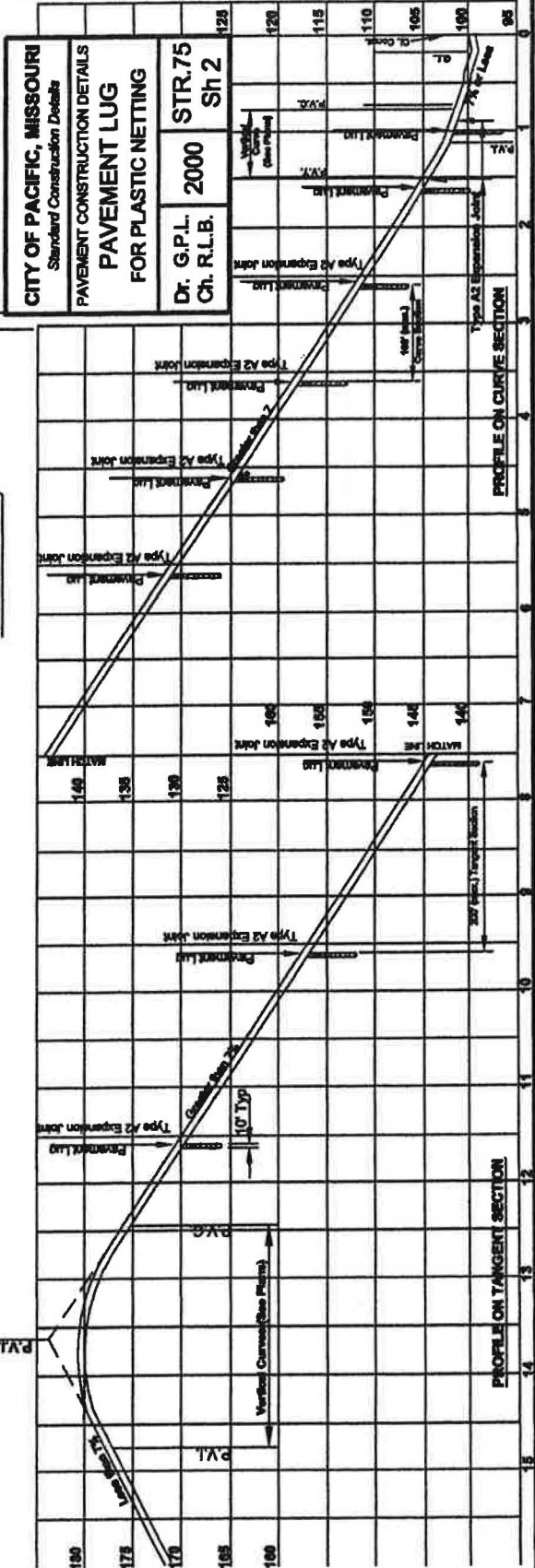
CITY OF PACIFIC, MISSOURI		
Standard Construction Details		
PAVEMENT CONSTRUCTION DETAILS		
PAVEMENT LUG		
Dr. G.P.L. Ch.R.L.B.	2000	STR.75 Sh 1

GENERAL NOTES:

1. Do not scale drawings. Follow dimensions.
2. Construction details for the Pavement Lug are shown on the Pavement Construction Details for "Pavement Lug," Standard Drawing.
3. For Type A2 Joint requirements refer to the Pavement Construction Details for "Joints and Curbs," Standard Drawing.
4. Pavement Lug is not required if the distance to the high point of the Vertical Curve is less than 200'.
5. For pavement width and thickness and horizontal and vertical alignment see the Construction Plans.
6. Pavement Lugs in the field may be adjusted to eliminate conflicts with sanitary or storm pipes and structures as directed by the Department.
7. The stationing and elevations shown on this drawing are for illustration only. For the actual stationing and elevations see the Construction Plans.



PLAN



PROFILE ON TANGENT SECTION

PROFILE ON CURVE SECTION

CITY OF PACIFIC, MISSOURI

Standard Construction Details

PAVEMENT CONSTRUCTION DETAILS

PAVEMENT LUG

FOR PLASTIC NETTING

Dr. G.P.L. 2000

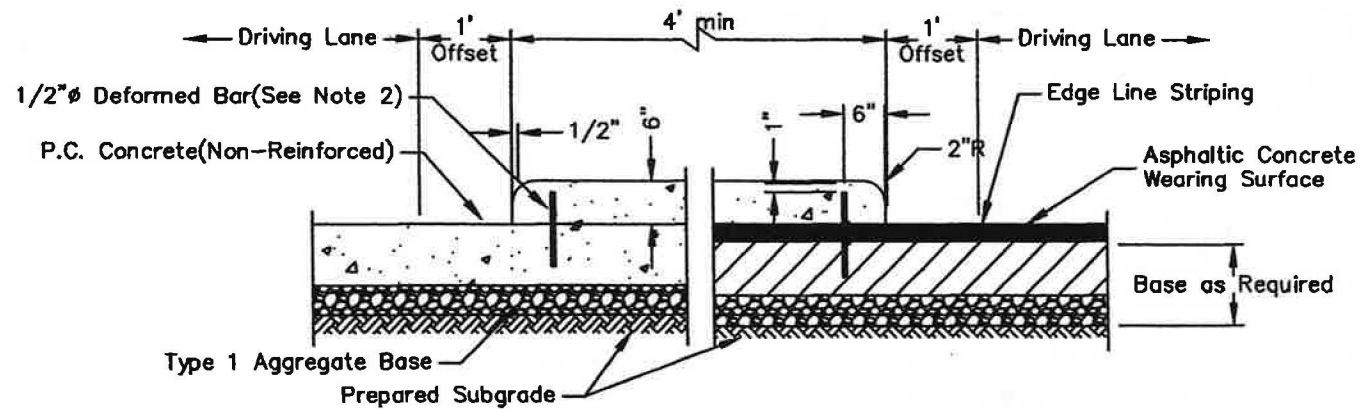
Ch. R.L.B.

STR.75

Sh 2

GENERAL NOTES:

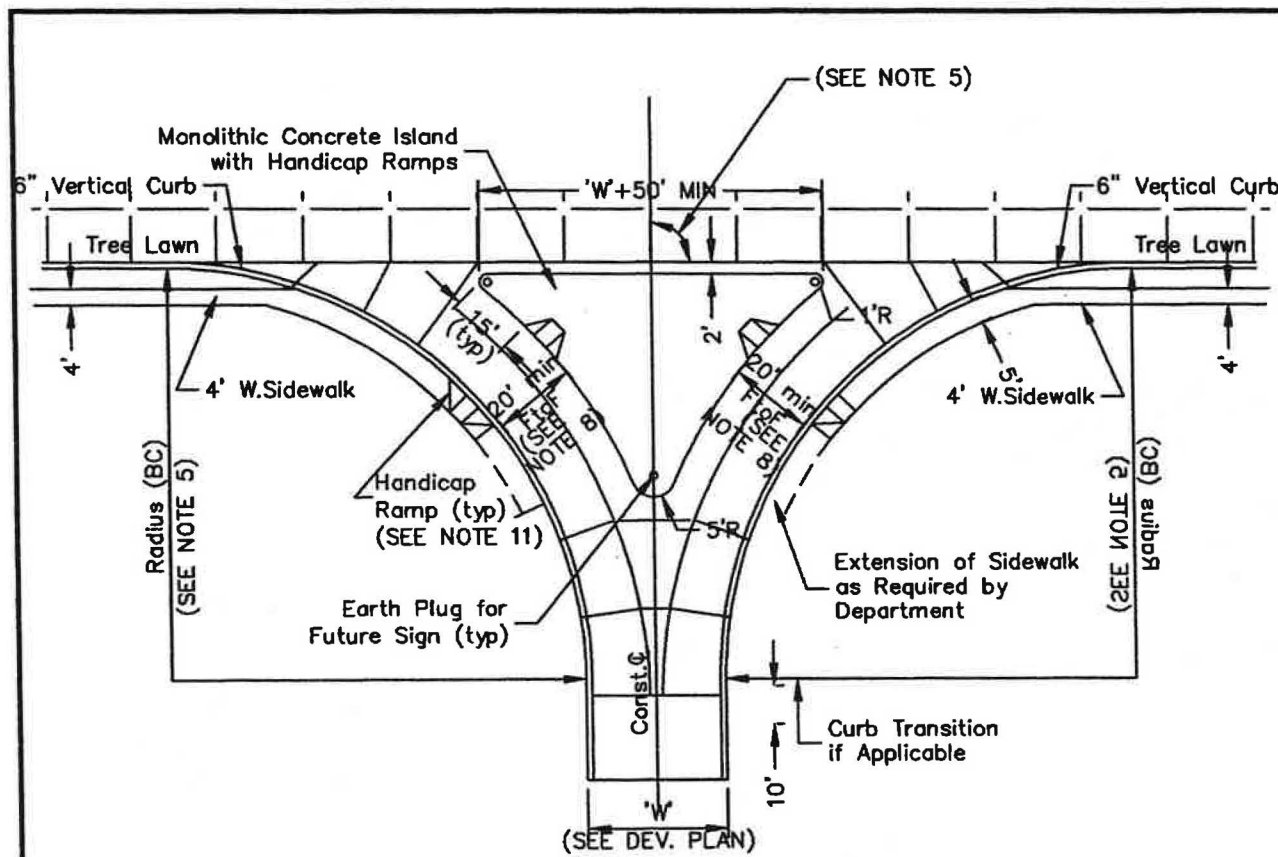
- 1) Do not scale drawing. Follow dimensions.
- 2) Length of the tie bars shall equal the thickness of pavement plus the height of curb less 3". Tie bars shall be placed at 24" centers.
- 3) All necessary pavement markings by City of Pacific, MO.
- 4) See Standard Details STR.01-STR.12 for pavement and base thickness.



P.C. Concrete Pavement

Asphaltic Concrete Pavement Surface

CITY OF PACIFIC, MISSOURI		
Standard Construction Details		
PAVEMENT CONSTRUCTION DETAILS		
6" RAISED DOWELED- ON CONCRETE MEDIAN		
Dr. G.P.L. Ch. R.L.B.	2000	STR.76



GENERAL NOTES:

- 1) Sections are symmetrical about construction centerline.
- 2) For roadway cross slopes, pavement types and thickness refer to STR.01-STR.12
- 3) All necessary pavement markings by the City of Pacific, MO.
- 4) Each corner radius shall be as required by the geometric layout shown and increased to the nearest 5 foot dimension. The minimum acceptable corner radius shall not be less than 50 feet.
- 5) The intersection angle shall be designed at 90° is approved by this Department.
- 6) Greater channelization lane widths may be required if an intersection angle less than 90° is approved by this Department.
- 7) For longitudinal and transverse joints, dowel and tie bar requirements and curb dimensions refer to STR.70 Note that width and location of each poured portion of the pavement may change the type and location of the joint required.
- 8) The location of the Type B and F longitudinal construction joints in the sections may be interchanged for the different widths of construction if approved by the Department.
- 9) Handicap ramps are required with sidewalk and curb.
See Standard Detail STR.17.

- 10) Transverse or longitudinal construction joints in slip formed pavement may be made with a groover or tool, if such device has been approved in advance by the Department.
- 11) All catch basins shall be separate from the pavement and curb by expansion joint material extending completely through curb and slab.
- 12) When a joint falls 5 feet of, or contacts basin, manholes, or other structures, shorten one or more panels either side of opening to permit joint to fall on round structures and at or between corners of rectangular structures.
- 13) Sidewalk thickness increases is 4" thru Residential Driveways and 7" thru Commercial Driveways.

- 14) Driveway configurations are shown in Standard Details STR.21-STR.24.
- 15) Additional pavement thickness and/or base is required for heavy vehicular usage and volume.
Minimum Thickness for Pavement is:
CONCRETE (T)

All Residential Minor and Local Streets	6"
Residential Collector, All County and Non-Residential Streets and All Commercial Entrances.	7"
All Arterial Streets	8"

CITY OF PACIFIC, MISSOURI Standard Construction Details		
INTERSECTION CHANNELIZATION DETAILS		
RIGHT IN - RIGHT OUT CHANNELIZED STREET OR COMMERCIAL ENTRANCE		
Dr. G.P.L. Ch. R.L.B.	2000	STR. 77

1) Porous backfill of transverse underdrains shall extend a minimum distance of shoulder line to shoulder line for flexible pavement and a minimum of 18 inches outside of each edge for rigid pavement slabs.

1) Porous bed of transverse underdrains shall extend a minimum distance of shoulder line to shoulder line for flexible pavement and a minimum of 18 inches outside of each edge for rigid pavement slabs.

3) All underdrain pipes outside the limits of porous backfill shall be laid with perforations up and covered with two layers of tar paper prior to placing earth backfill or shall be under drain pipe that is not perforated.

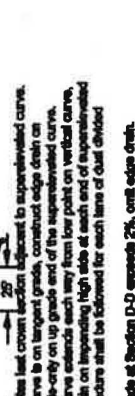
5) One layer of tar paper shall be placed over the top of all porous bedfills which is not directly under the pavement or subbase.

7) Outlets of underdrain pipe in cuts shall be a minimum of 6 inches above bottom of ditch.

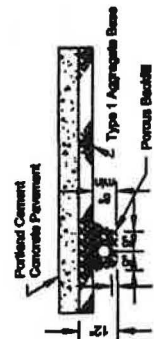
6) Regardless of the depth shown on the development plans, underdrains shall be set down into any impervious layer so as to definitely intercept seepage.

11) Maximum length of underdrain pipe between outlets shall be approximately 100 feet.

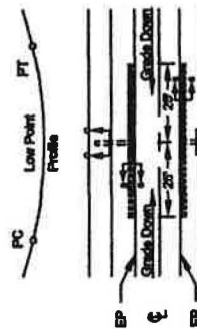
12) The sketches shown on this sheet are not drawn to scale and are only intended as a general guide for placing and constructing underdrains. The actual location and construction shall be directed by an engineer.



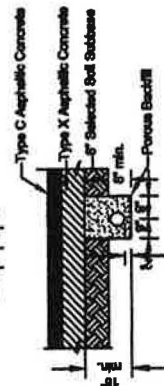
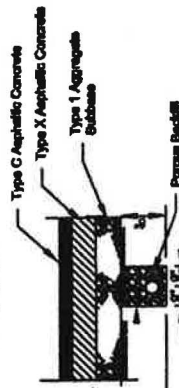
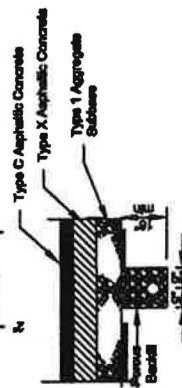
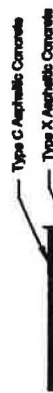
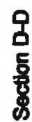
Section A-A



Section A-A



Section D:
If supervisor
impending
If supervisor
conduct a
curve. See
pavement
"When he

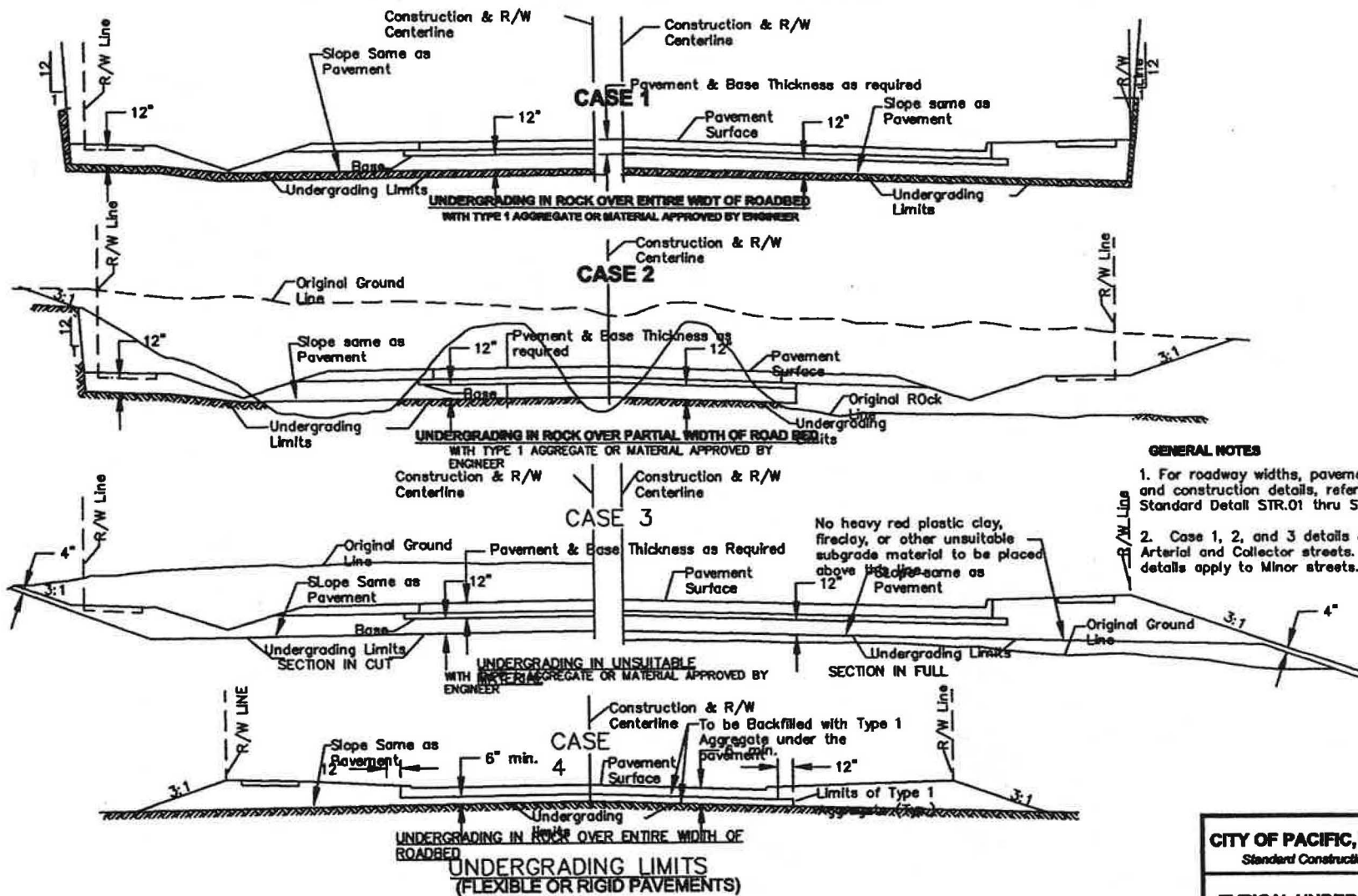


FLEXIBLE PAVEMENT

Section D-D

RIGID PAVEMENT

CITY OF PACIFIC, MISSOURI <i>Standard Construction Details</i>	PAVEMENT CONSTRUCTION DETAILS	
	CLASS A UNDERDRAINS	Dr. G.P.L. Ch. R.L.B.
	2000	STR. 80



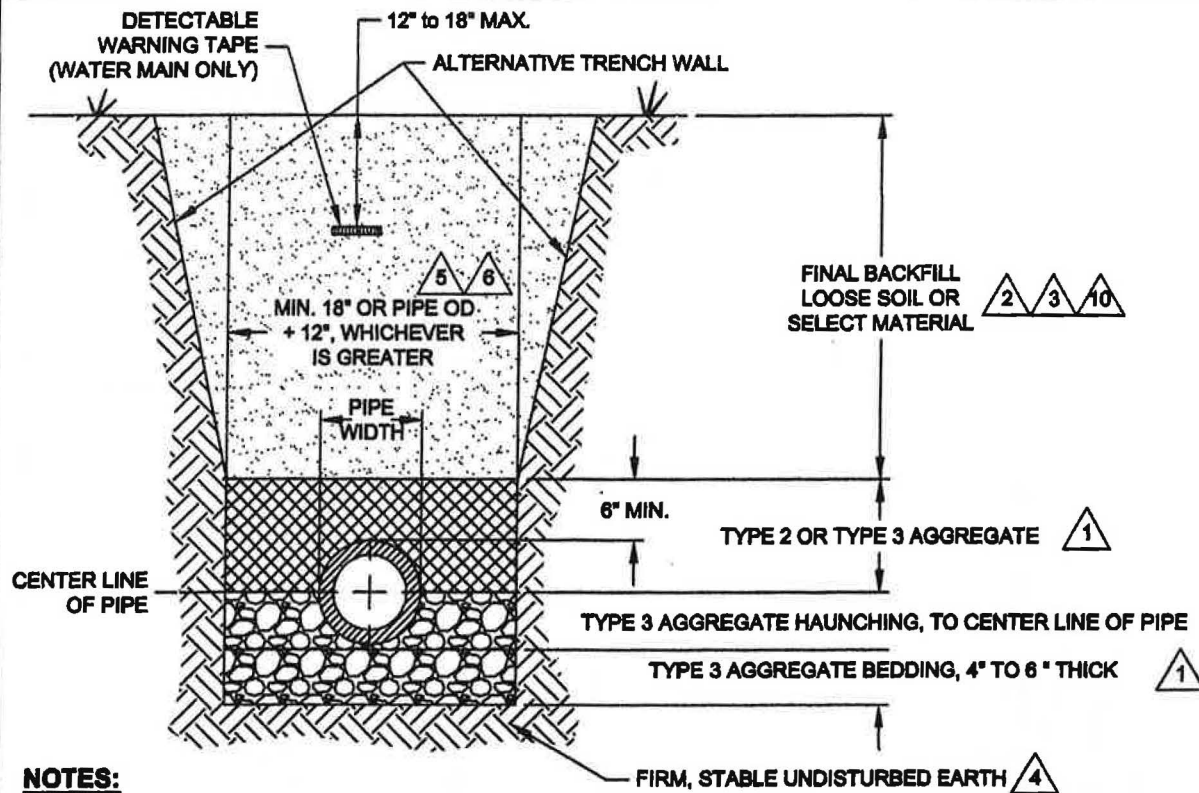
GENERAL NOTES

1. For roadway widths, pavement types and construction details, refer to Standard Detail STR.01 thru STR.12.
2. Case 1, 2, and 3 details apply to Arterial and Collector streets. Case 4 details apply to Minor streets.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

TYPICAL UNDERGRADING DETAILS

Dr. G.P.L. Ch. R.L.B.	2000	STR.90
--------------------------	------	--------



NOTES:

1. COMPACT TO 90% STANDARD PROCTOR DENSITY, AASHTO T-99.
2. LOOSE SOIL IS DEFINED AS "NATIVE SOIL EXCAVATED FROM THE TRENCH, FREE OF ROCKS, FOREIGN MATERIAL, AND FROZEN EARTH". SOIL SHALL BE PRESSED DOWN WITH WHEEL OR TRACK OF TRENCHING/BACKFILLING MACHINE OR LEFT WITH A 3" HIGH MOUND OVER THE TRENCH TO ALLOW FOR SETTLEMENT.
3. WHERE TRENCH WILL BE UNDER PAVED SURFACE (STREET, SIDEWALK, PARKING LOT, ETC.) FINAL BACKFILL TO BE TYPE 1, TYPE 2, OR TYPE 3 AGGREGATE COMPACTED TO 90% STANDARD PROCTOR DENSITY, AASHTO T-99.
4. IF UNSTABLE SUB-GRADE IS ENCOUNTERED, EXCAVATE TO FIRM, STABLE MATERIAL AND BACKFILL WITH TYPE 3 AGGREGATE, COMPACTED TO 90% STANDARD PROCTOR DENSITY, AASHTO T-99.
5. IF TRENCH WIDTH IS EXCEEDED, PIPE EMBEDMENT AND BACKFILL TO BE COMPACTED TO A POINT OF AT LEAST 2.5 PIPE DIAMETERS FROM THE PIPE ON BOTH SIDES OF THE PIPE OR TO THE TRENCH WALLS, WHICHEVER IS LESS.
6. WHENEVER POSSIBLE, CLEAR WIDTH OF TRENCH AT TOP OF PIPE SHOULD NOT EXCEED PIPE OD PLUS 24 INCHES.
7. LEDGE ROCK, BOULDERS AND LARGE STONES SHOULD BE REMOVED TO PROVIDE 6 INCHES OF BEDDING UNDER PIPE AND ACCESSORIES.
8. THIS DETAIL MODIFIES AND SATISFIES THE REQUIREMENTS OF WATER MAIN TRENCH AND BEDDING DETAILS TYPE 5 PER AWWA C150, AWWA C800 AND AWWA C805.
9. SEE SECTION 8.1 FOR AGGREGATE TYPES.
10. 36" MIN. FOR WATER LINES.
11. DETECTABLE WARNING TAPE AS MANUFACTURED BY SAFETY PRODUCTS, OR EQUAL. TAPE SHALL BE 3-INCH WIDE, CODED COLOR BLUE, AND HAVE TEXT DENOTING "CAUTION: BURIED WATER LINE BELOW".
12. WATER MAIN TO BE FITTED WITH SINGLE THWN #12 COPPER LOCATOR WIRE.

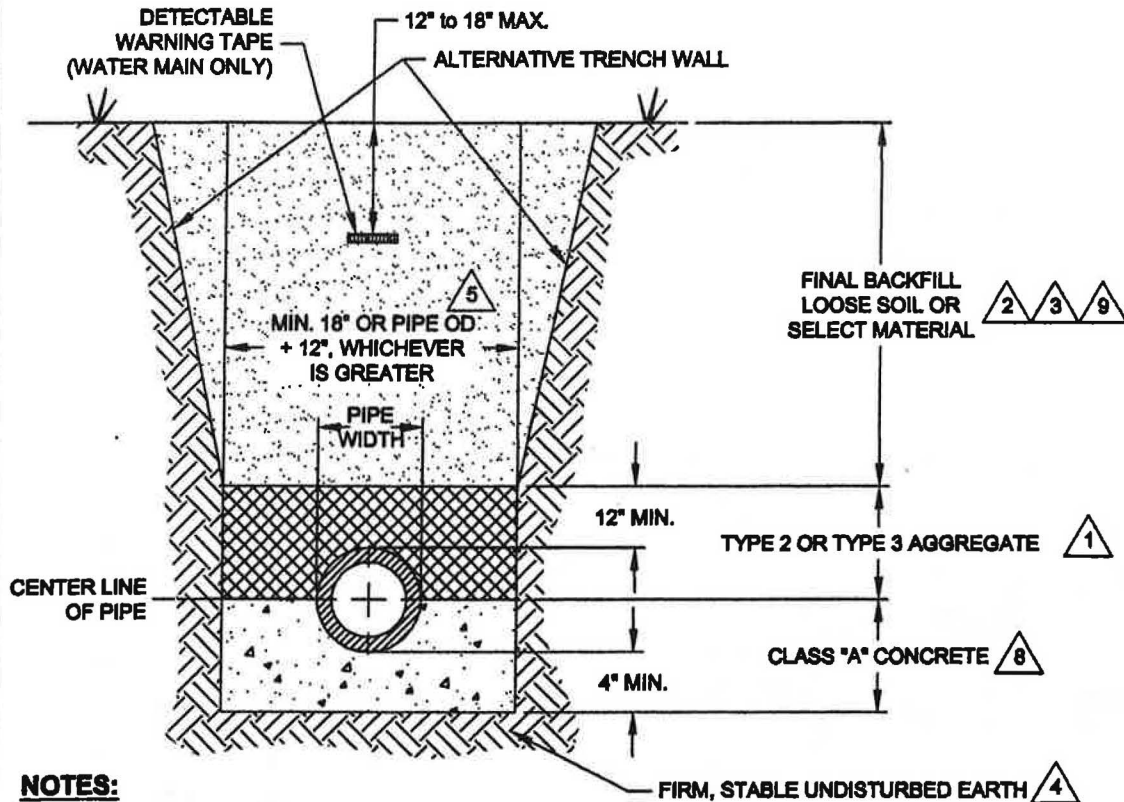
**PIPE TRENCHING AND
BEDDING DETAILS**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

PIP.01



NOTES:

1. COMPACT TO 90% STANDARD PROCTOR DENSITY, AASHTO T-99.
2. LOOSE SOIL IS DEFINED AS "NATIVE SOIL EXCAVATED FROM THE TRENCH, FREE OF ROCKS, FOREIGN MATERIAL, AND FROZEN EARTH". SOIL SHALL BE PRESSED DOWN WITH WHEEL OR TRACK OF TRENCHING/BACKFILLING MACHINE OR LEFT WITH A 3" HIGH MOUND OVER THE TRENCH TO ALLOW FOR SETTLEMENT.
3. WHERE TRENCH WILL BE UNDER PAVED SURFACE (STREET, SIDEWALK, PARKING LOT, ETC.) FINAL BACKFILL TO BE TYPE 1, TYPE 2, OR TYPE 3 AGGREGATE COMPACTED TO 90% STANDARD PROCTOR DENSITY, AASHTO T-99.
4. IF UNSTABLE SUB-GRADE IS ENCOUNTERED, EXCAVATE TO FIRM, STABLE MATERIAL AND BACKFILL WITH TYPE 3 AGGREGATE, COMPACTED TO 90% STANDARD PROCTOR DENSITY, AASHTO T-99.
5. IF TRENCH WIDTH IS EXCEEDED, PIPE EMBEDMENT AND BACKFILL TO BE COMPACTED TO A POINT OF AT LEAST 2.5 PIPE DIAMETERS FROM THE PIPE ON BOTH SIDES OF THE PIPE OR TO THE TRENCH WALLS, WHICHEVER IS LESS.
6. LEDGE ROCK, BOULDERS AND LARGE STONES SHOULD BE REMOVED TO PROVIDE 4 INCHES OF CONCRETE CRADLE UNDER ALL PIPE AND ACCESSORIES.
7. SEE SECTION 8.1 FOR AGGREGATE TYPES.
8. FOR PLASTIC PIPE, USE CONCRETE COLLARS 2 FEET LONG AND 6 INCHES THICK EVERY 12 FEET ADJACENT TO AND DOWN STREAM OF BELLS (IN LIEU OF CONCRETE CRADLE).
9. 36" MIN. FOR WATER LINES.
10. DETECTABLE WARNING TAPE AS MANUFACTURED BY SAFETY PRODUCTS, OR EQUAL. TAPE SHALL BE 3-INCH WIDE, CODED COLOR BLUE, AND HAVE TEXT DENOTING "CAUTION: BURIED WATER LINE BELOW".
11. WATER MAIN TO BE FITTED WITH SINGLE THWN #12 COPPER LOCATOR WIRE.

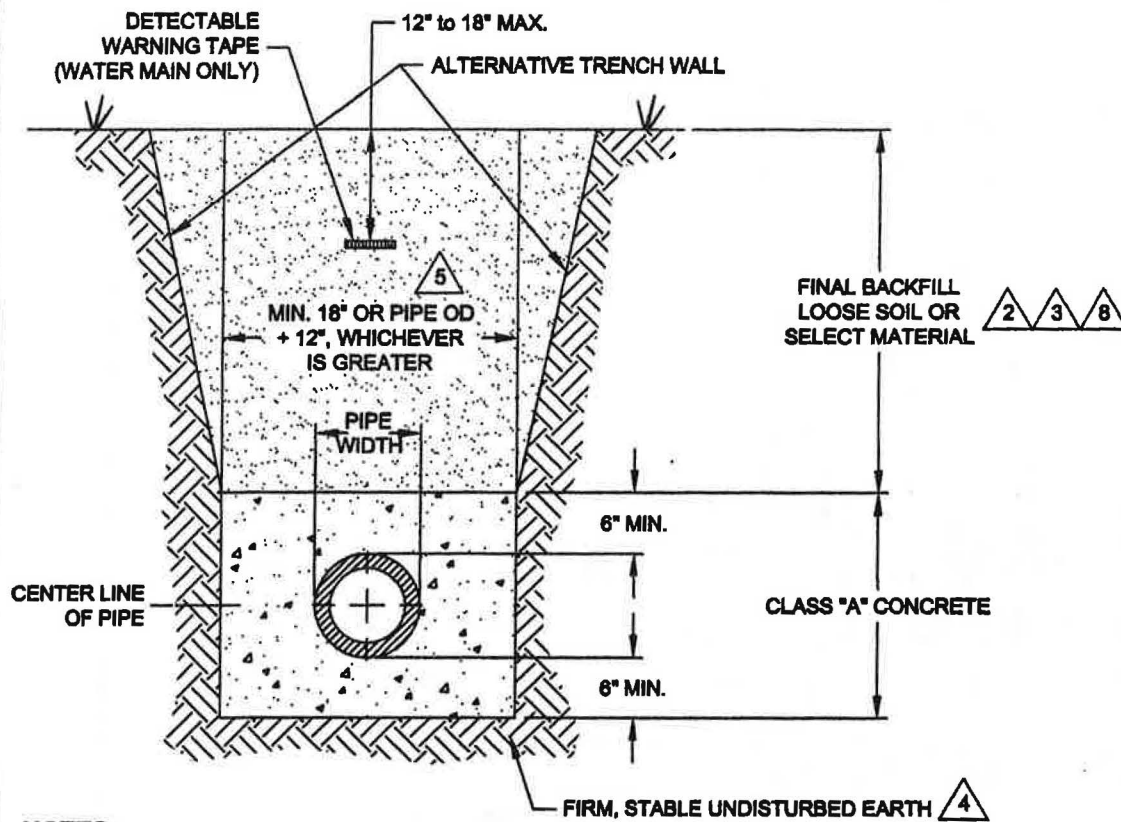
CONCRETE CRADLE

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

PIP.02



NOTES:

1. SUPPORT PIPE TO PREVENT DISPLACEMENT DURING PLACEMENT CONCRETE. EXTEND CONCRETE TO UNDISTURBED EARTH AND PLACE CONCRETE WITHOUT HORIZONTAL CONSTRUCTION JOINTS.
2. LOOSE SOIL IS DEFINED AS "NATIVE SOIL EXCAVATED FROM THE TRENCH, FREE OF ROCKS, FOREIGN MATERIAL, AND FROZEN EARTH". SOIL SHALL BE PRESSED DOWN WITH WHEEL OR TRACK OF TRENCHING/BACKFILLING MACHINE OR LEFT WITH A 3" HIGH MOUND OVER THE TRENCH TO ALLOW FOR SETTLEMENT.
3. WHERE TRENCH WILL BE UNDER PAVED SURFACE (STREET, SIDEWALK, PARKING LOT, ETC.) FINAL BACKFILL TO BE TYPE 1, TYPE 2, OR TYPE 3 AGGREGATE COMPACTED TO 90% STANDARD PROCTOR DENSITY, AASHTO T-99.
4. IF UNSTABLE SUB-GRADE IS ENCOUNTERED, EXCAVATE TO FIRM, STABLE MATERIAL AND BACKFILL WITH TYPE 3 AGGREGATE, COMPACTED TO 90% STANDARD PROCTOR DENSITY, AASHTO T-90.
5. IF TRENCH WIDTH IS EXCEEDED, PIPE EMBEDMENT AND BACKFILL TO BE COMPACTED TO A POINT OF AT LEAST 2.5 PIPE DIAMETERS FROM THE PIPE ON BOTH SIDES OF THE PIPE OR TO THE TRENCH WALLS, WHICHEVER IS LESS.
6. LEDGE ROCK, BOULDERS AND LARGE STONES SHOULD BE REMOVED TO PROVIDE 6 INCHES OF CONCRETE ENCASEMENT UNDER ALL PIPE AND ACCESSORIES.
7. SEE SECTION 8.1 FOR AGGREGATE TYPES.
8. 36" MIN. FOR WATER LINES.
9. DETECTABLE WARNING TAPE AS MANUFACTURED BY SAFETY PRODUCTS, OR EQUAL. TAPE SHALL BE 3-INCH WIDE, CODED COLOR BLUE, AND HAVE TEXT DENOTING "CAUTION: BURIED WATER LINE BELOW".
10. WATER MAIN TO BE FITTED WITH SINGLE THWN #12 COPPER LOCATOR WIRE.

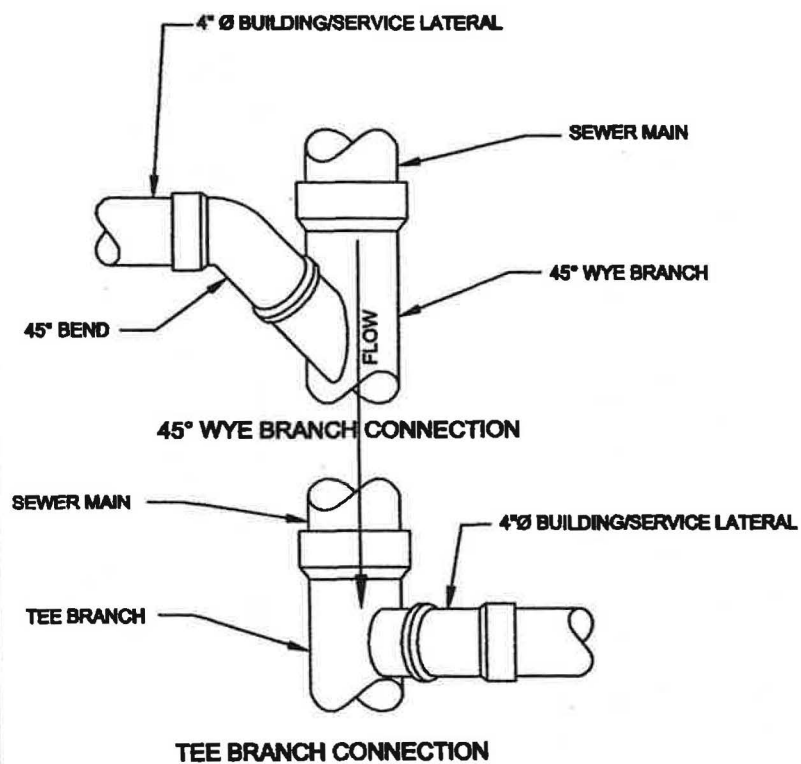
CONCRETE ENCASEMENT

CITY OF PACIFIC, MISSOURI
Standard Construction Details

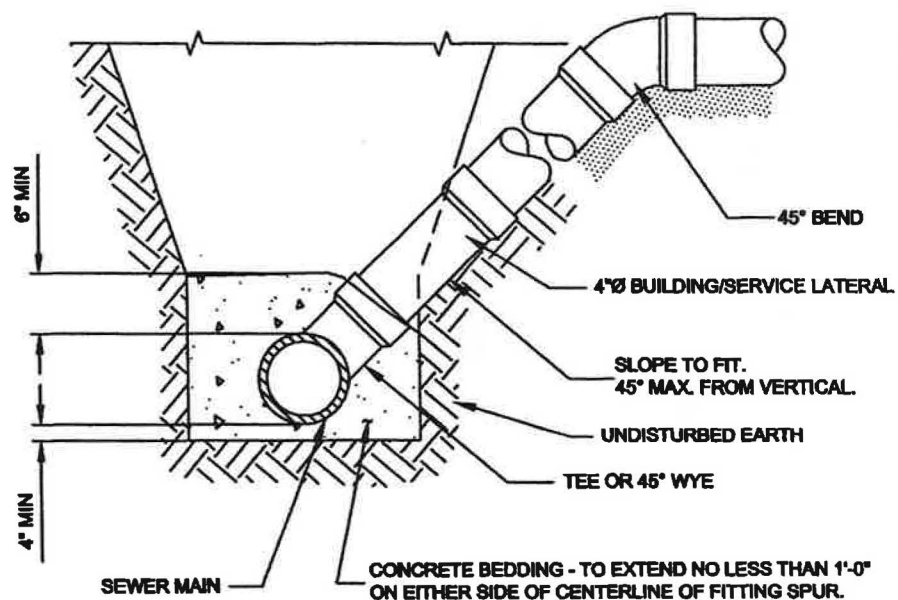
Dr. T.R.L.
Ch. R.L.B.

2000

PIP.03



PLAN VIEW

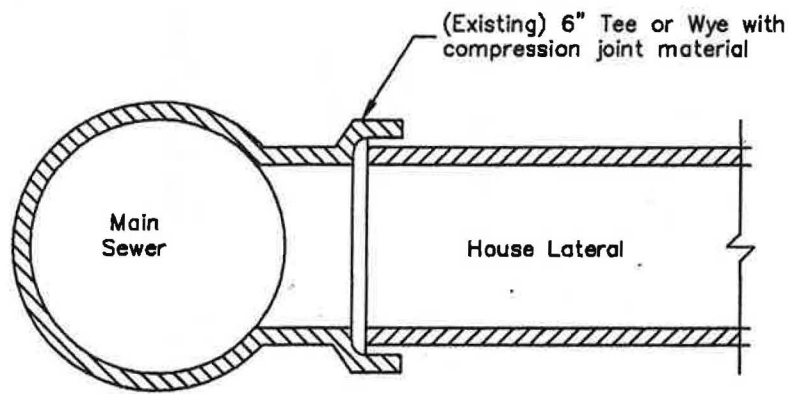


ELEVATION VIEW

CITY OF PACIFIC, MISSOURI
Standard Construction Details

**TYPICAL SERVICE
 CONNECTION**

Dr. T.R.L. Ch. R.L.B.	2000	PIP.04
--------------------------	------	--------



HOUSE CONNECTION

NOTES:

- 1) 6 inch V.C.P. without compression joint shown.
- 2) 6 inch V.C.P. without compression joint. Use sewer title and oakum.
- 3) If 4 inch house connection is approved, a 4 inch to 6 inch increaser is required.
- 4) If 6 inch P.V.C. is used a Fernco Adapter or sewer title and oakum may be used.
- 5) A clean, dry bedding material is required around the completed connection before backfilling. The bedding material shall be one of the following:
 - A. Pacific Type 3 Aggregate Bedding
 - B. 1 to 3 cement and sand.
 - C. Pre-mix concrete.

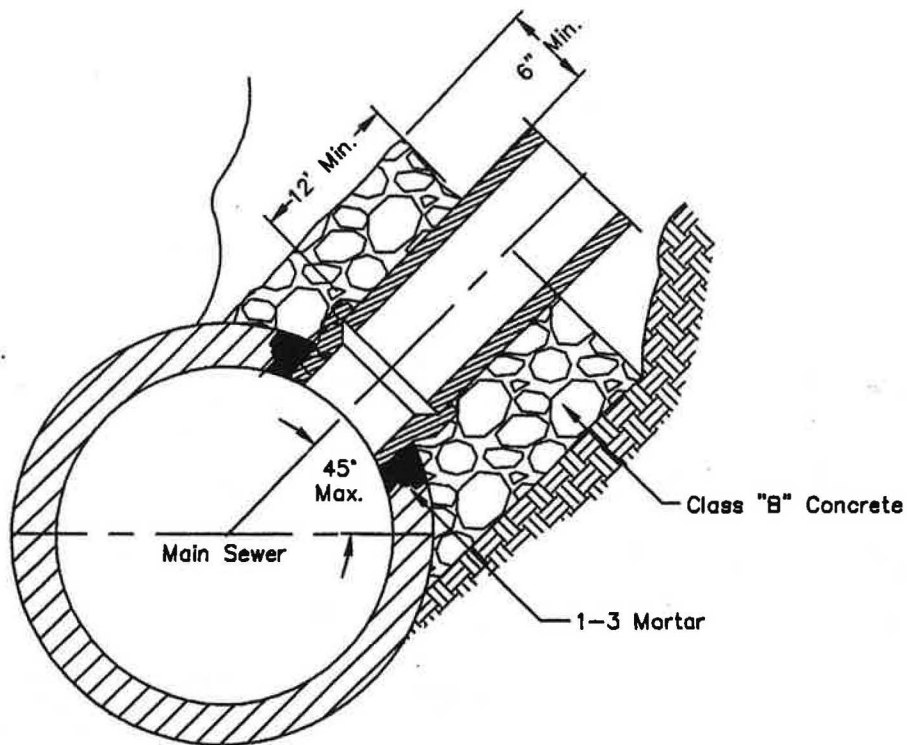
HOUSE CONNECTION
TO EXISTING
TEE OR WYE

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

P.I.P.,05



NOTES:

1. The opening shall be cut by the contractor to a sufficient size to permit inserting a tee saddle or short length of pipe at the required elevation and angle to allow at least 2 inches space around the pipe. This space will be solidly filled with 1-3 cement - sand mortar and the new pipe neatly trimmed and painted up flush with the inside of the main sewer.
2. If there are reinforcing bars in the sewer wall, only those preventing insertion of the pipe may be out. All others shall be bent into a class "B" concrete collar at the junction of the connection pipe and the main sewer.

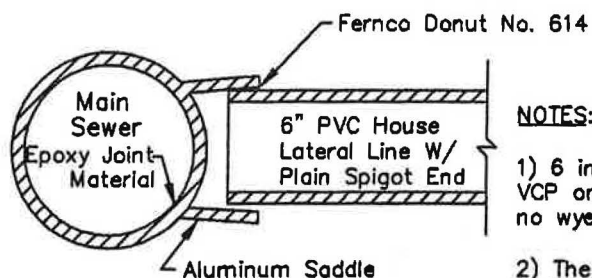
**HOUSE CONNECTIONS
ALLOWED BY
TEE SADDLE**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. G.P.L.
Ch. R.L.B.

2000

PIP.06



NOTES:

1) 6 inch VCP or 6 inch PVC house connection into public VCP or public PVC main 8 inch to 24 inch diameter and no wye or tee available, a machine tap is required.

2) The City will cut the hole in the main, provide and epoxy the saddle to the main. All other material and labor are the responsibility of the contractor.

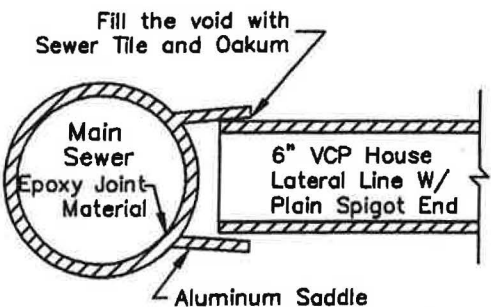
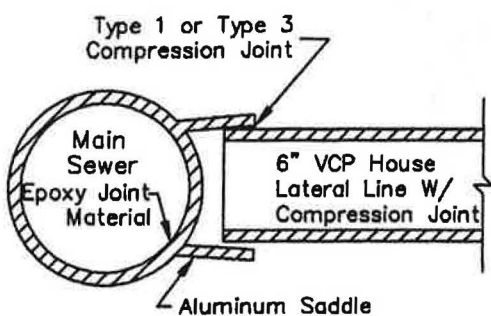
3) A cleandry bedding material is required around the complete connection before back filling. The bedding material shall be one of the following:

- A. Pacific Type 3 Aggregate Bedding
- B. 1 to 3 Cement to Sand
- C. Pre-Mix Concrete

4) If 4 inch house connection is approved, a 4 inch to 6 inch increaser is required at machine tap.

5) All excavation must be adequately braced before City will make an inspection.

6) All material required to make an approved connection must be on the connection site at the time of arrival of the tap truck. If the material is not available, the tap must be rescheduled.



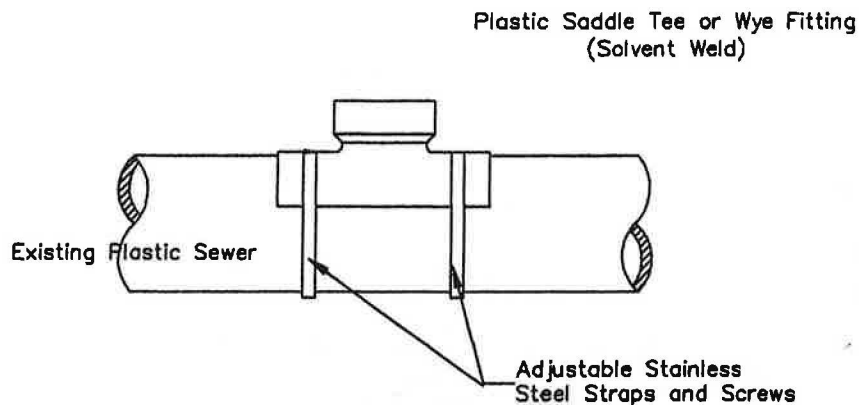
MACHINE TAP

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

PIP.07



When a connection to a plastic pipe is allowed and a connection is largest than 6 inches in diameter, a solvent weld wye or tee fitting of a similar material must be used. (Example: 10"x 8")

This is accomplished by careful cutting a hole with a saw in the main at the required location. After cutting and shaping the hole to the size of the fitting. The following steps should be taken:

1. Clean and dry both inside saddle wye surface and pipe surface to be solvent cemented.
2. Important: Apply a liberal, heavy coat of ONE-STEP SOLVENT CEMENT to the inside surface of the saddle wye and to the exterior welding surface to the pipe.
3. Without delay, mate the surfaces and strap down tightly. A bead of solvent should appear after the saddle has been strapped down tightly
4. Using a rag or paper towel, wipe bead and any excess solvent cement off pipe and saddle.
5. Allow 30-60 minutes for set-up time before backfilling. Cure time depends on size fit of materials being installed and various cold damp conditions.
6. Discard old solvent if it becomes jelled or lumpy.
7. A clean, dry bedding material is required around the completed connection before backfilling the bedding material should be one of the following:
 - A. Pacific Type 3 Aggregate Bedding
 - B. 1 to 3 Cement to Sand Mix
 - C. "Pre-Mix" Concrete

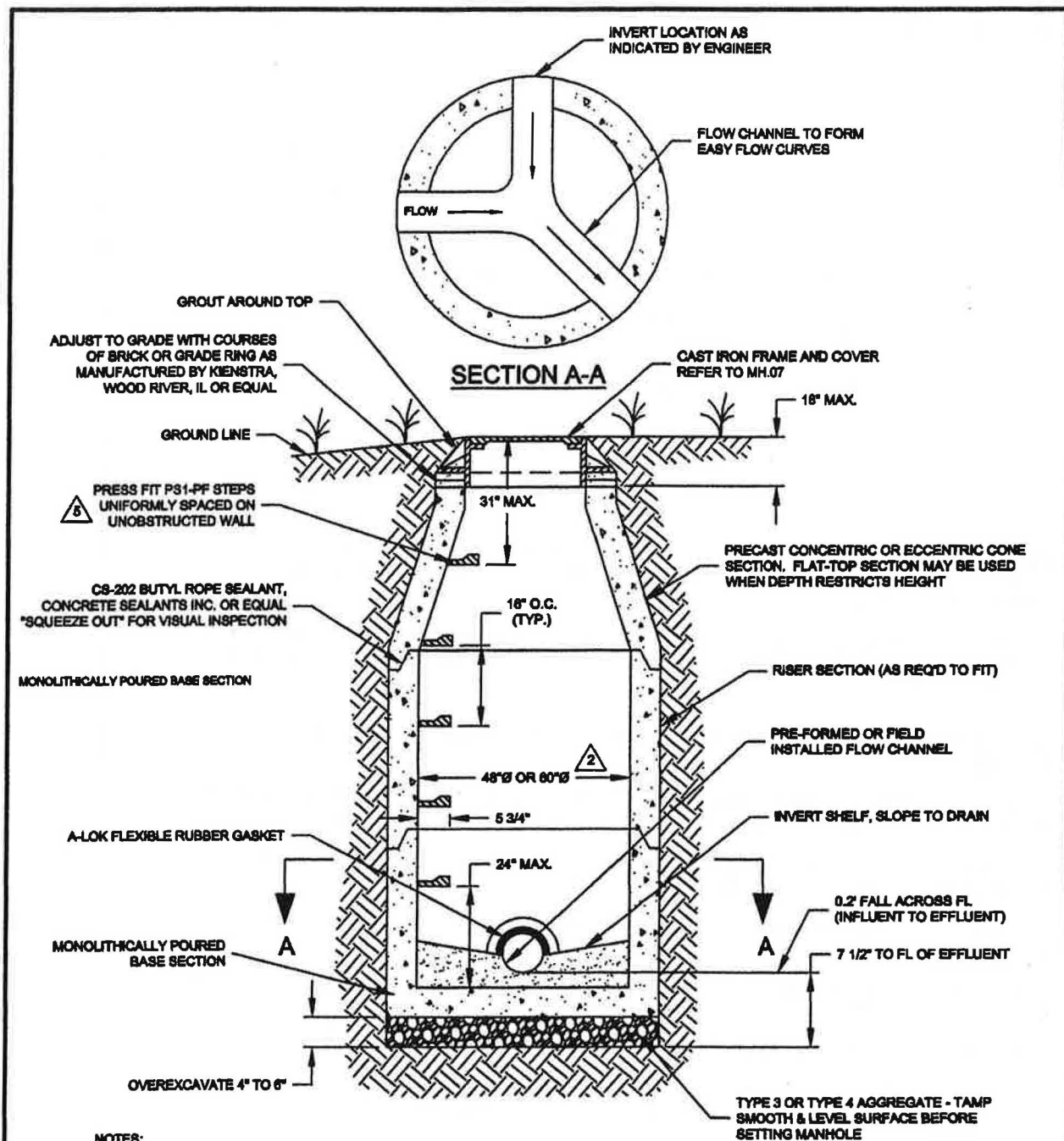
**8" (AND LARGER) CONNECTION
TO PLASTIC MAIN**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

PIP.08



NOTES:

1. FLOWLINE ELEVATION OF INCOMING PIPES SHALL BE 0.2 FEET HIGHER THAN THAT OF OUTGOING PIPE.
2. 48 INCH DIAMETER MANHOLE TO BE USED WITH 8 INCH DIAMETER TO 30 INCH DIAMETER SEWER PIPE. 60 INCH DIAMETER MANHOLE TO BE USED WITH 36 INCH DIAMETER TO 48 INCH DIAMETER SEWER PIPE.
3. WALL THICKNESS OF MANHOLE TO BE:
48 INCH ID - 5 INCH
60 INCH ID - 5 INCH

4. MANHOLES TO BE CONSTRUCTED PER ASTM C-478.

5. M.A. INDUSTRIES INC., PEACHTREE CITY, GA OR EQUAL

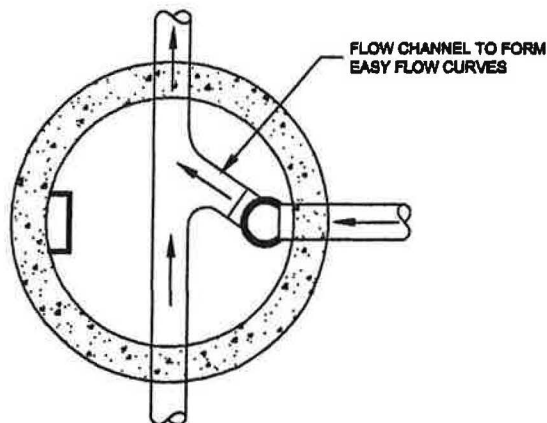
**PRECAST CONCRETE MANHOLE
FOR SEWERS**

**CITY OF PACIFIC, MISSOURI
Standard Construction Details**

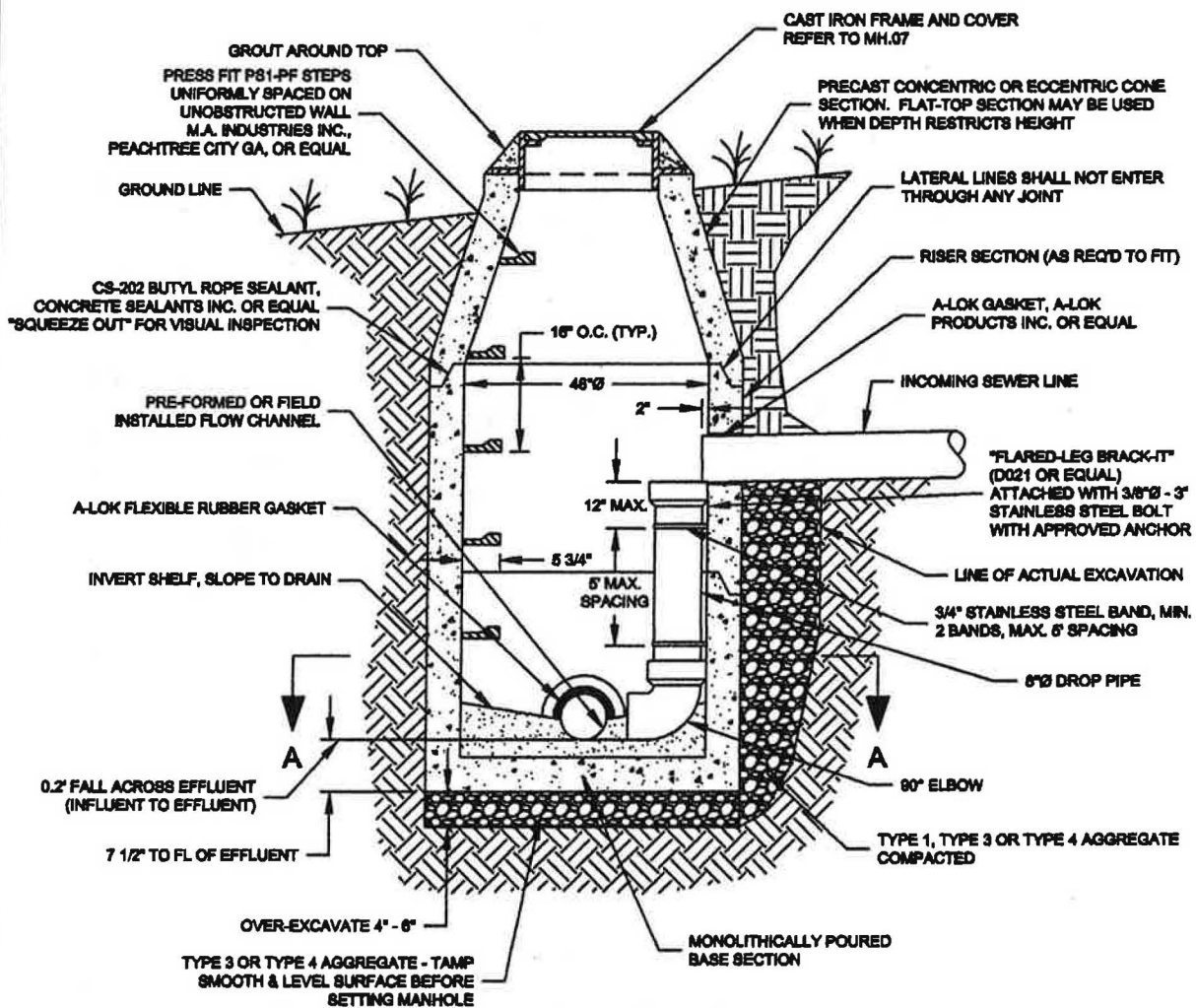
Dr. T.R.L.
Ch. R.L.B.

2000

MH.01



SECTION A-A



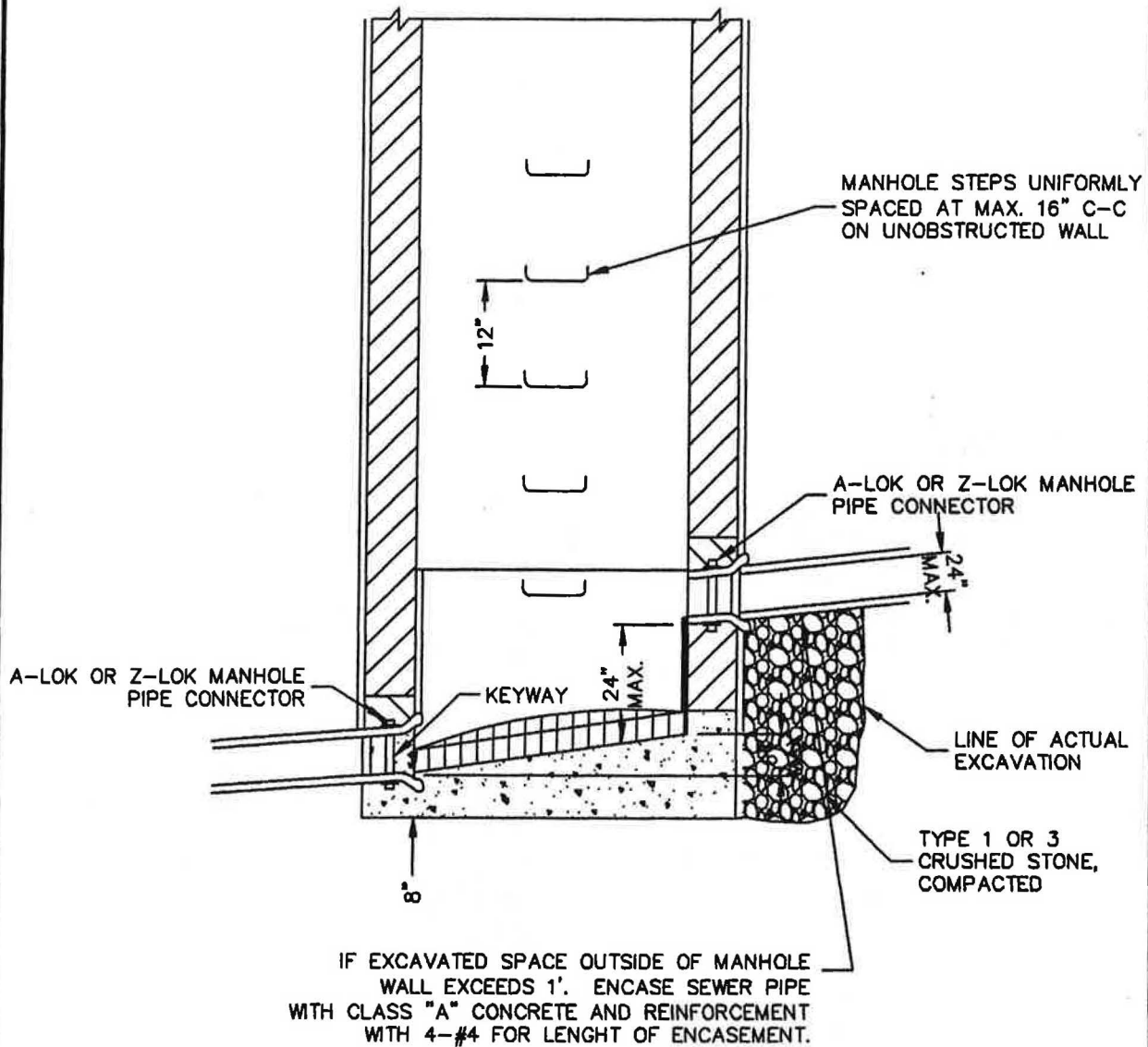
**INSIDE FOULWATER
DROP MANHOLE**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

MH.02



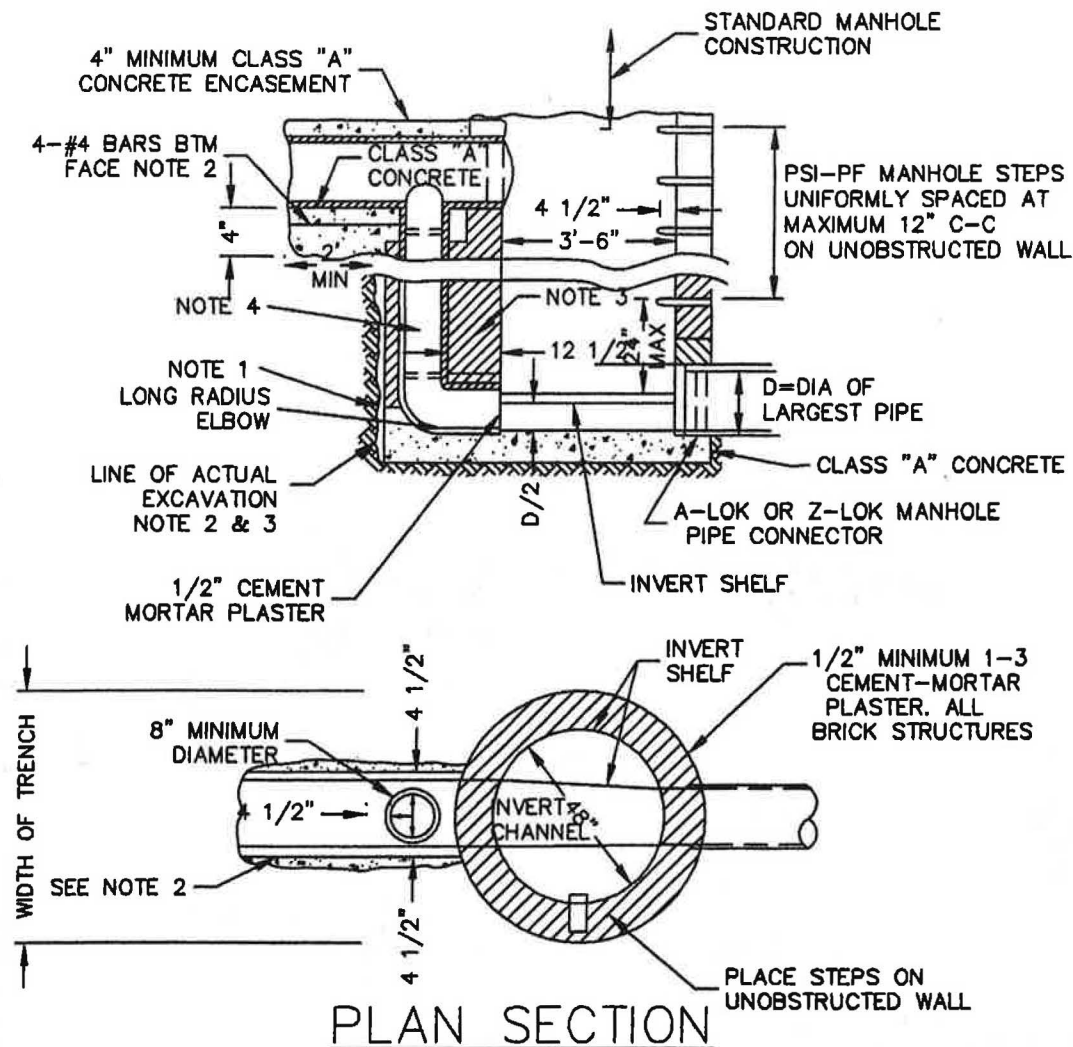
INSIDE FOULWATER
DROP MANHOLE
(FOR FREE-FALL)

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

MH.03



NOTES:

- 1) IF LINE OF ACTUAL EXCAVATION EXTENDS BEYOND LINE OF DROP MASONRY, FILL EXCESS EXCAVATED SPACE WITH CONSTRUCTION MATERIAL OF DROP OR PACK WITH COMPACTED TYPE 1 OR TYPE 3 CRUSHED STONE TO BASE OF CLASS "A" CONCRETE ENCASEMENT.
- 2) IF EXCAVATED SPACE OUTSIDE OF DROP PIPE MASONRY EXCEEDS 1 FOOT REINFORCE SEWER PIPE ENCASEMENT WITH A MINIMUM OF 4-#4 BARS FOR LENGTH OF ENCASEMENT
- 3) MASONRY ENCASEMENT OF DROP-PIPE SHALL BE BONDED AND PLACED INTEGRALLY WITH MANHOLE.
- 4) DIAMETER OF DROP PIPE FOR SANITARY SEWERS IS SAME AS INCOMING 8 INCH, 10 INCH OR 12 INCH PIPE SEWER, AND 12 INCH FOR LARGER SEWERS UNLESS OTHERWISE SHOWN ON PROJECT PLANS. FOR SANITARY SEWERS 15 INCH THROUGH 24 INCH A DROP IS NOT TO BE USED: CONNECT TO MANHOLE AT OR WITHIN 24 INCHES ABOVE ITS FLOWLINE.
- 5) NEW OUTSIDE DROP ON EXISTING MANHOLE REQUIRES #4 RE-BARS SPACED VERTICALLY AT 24 INCH C-C, ONE ON EACH SIDE OF PIPE, GROUTED THROUGH 2 INCH DIAMETER HOLES IN MANHOLE WALL (MIN. LENGTH OF BARS 18 INCHES).

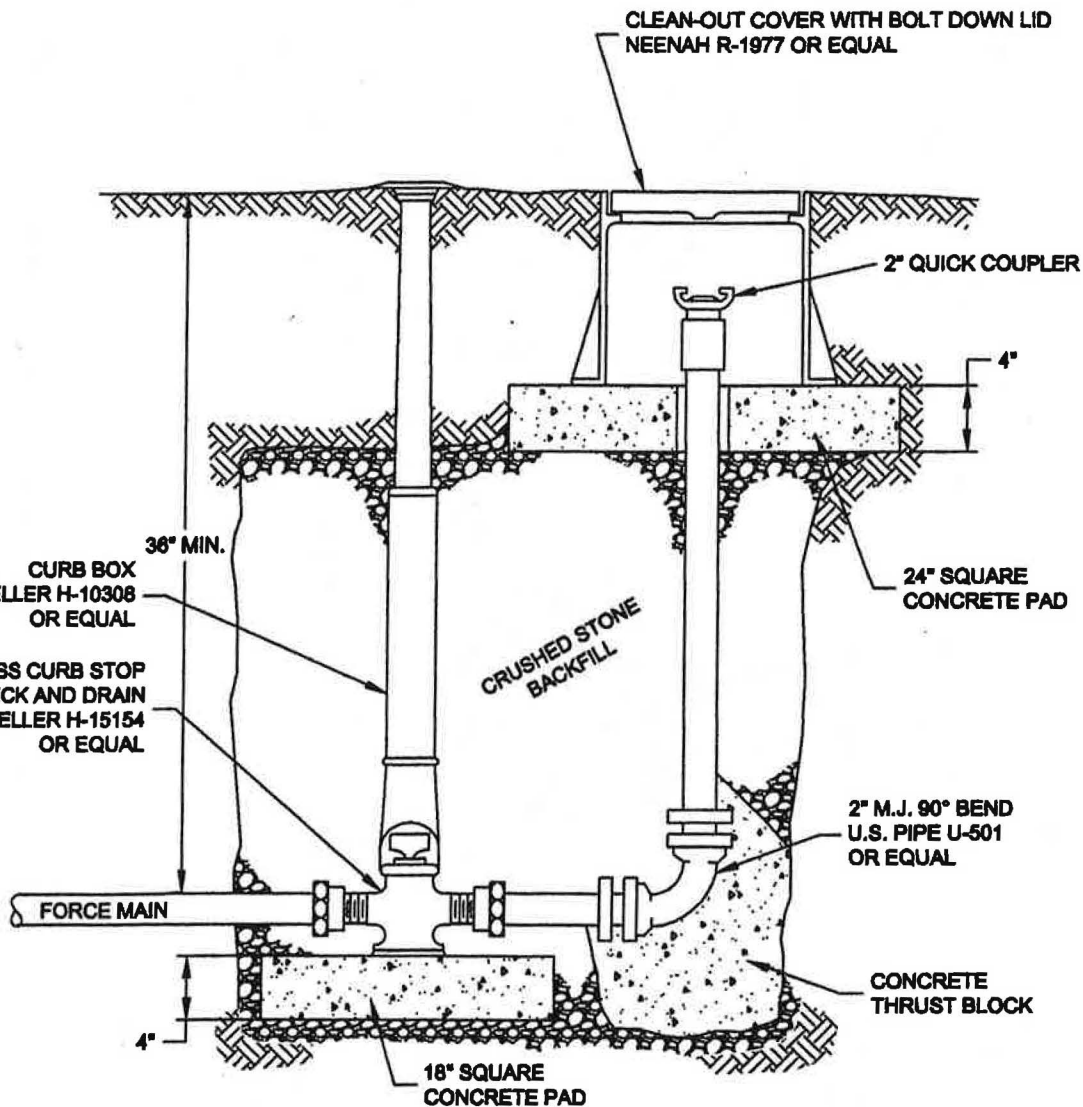
OUTSIDE FOULWATER
DROP MANHOLE

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

MH.04



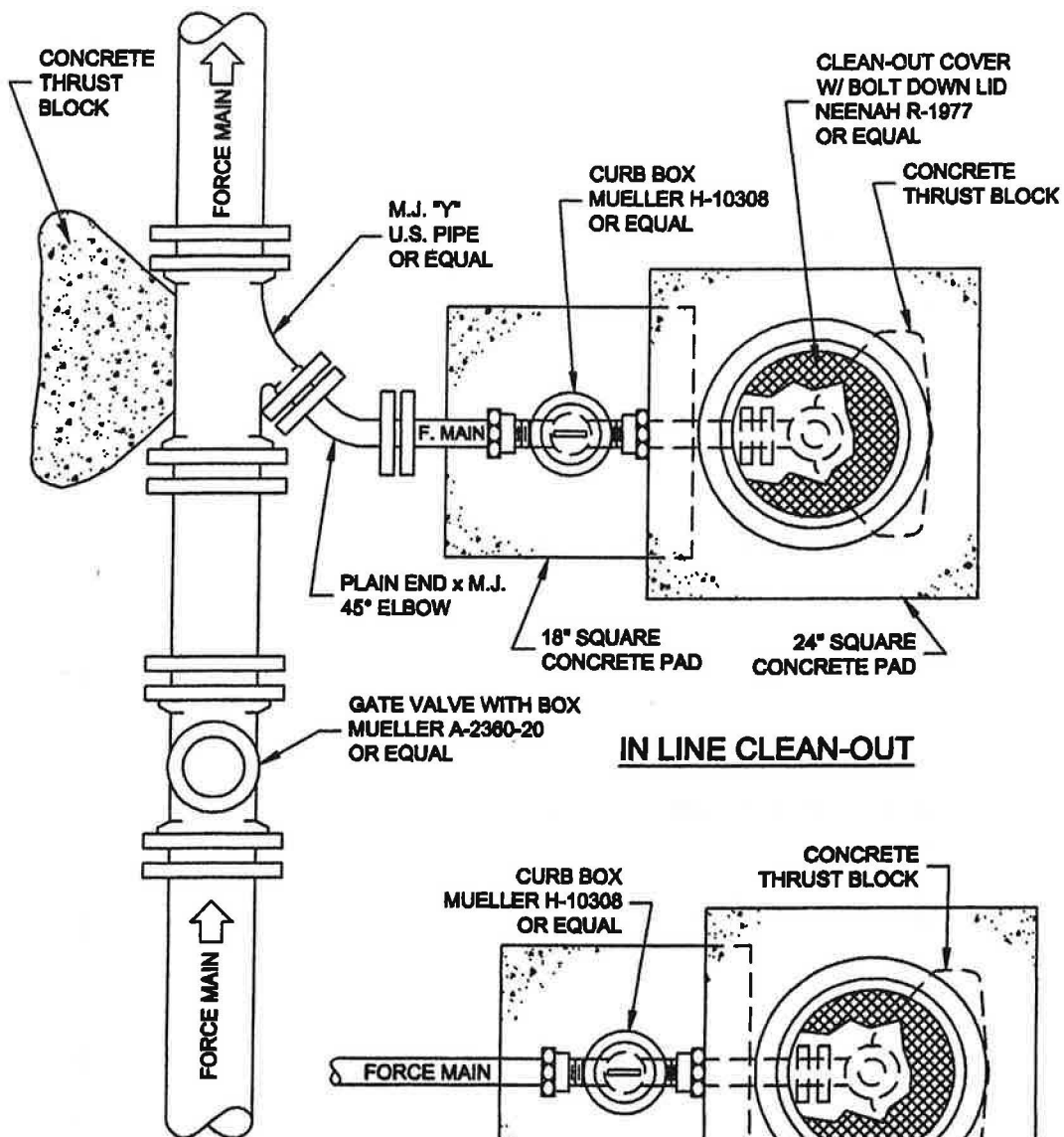
**TYPICAL FORCE MAIN
CLEAN-OUT
ELEVATION VIEW**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

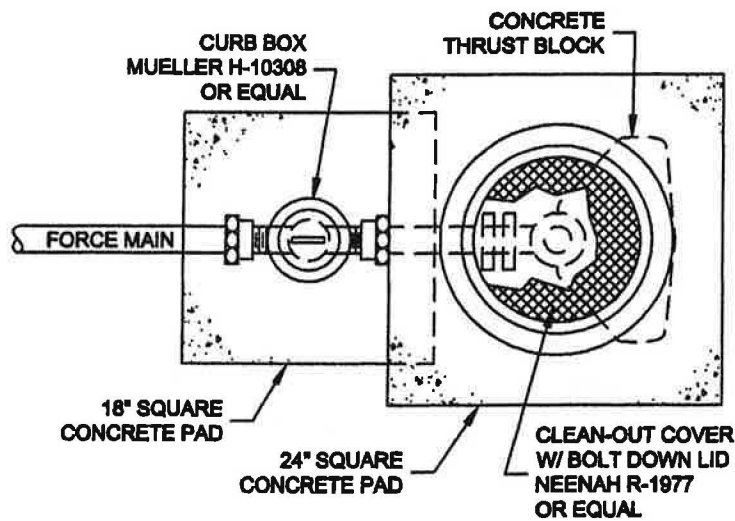
Dr. T.R.L.
Ch. R.L.B.

2000

MH.06
Sh 1



IN LINE CLEAN-OUT



TERMINAL CLEAN-OUT

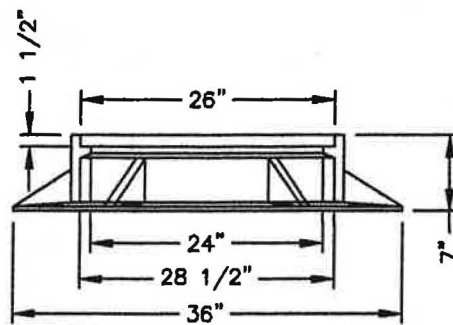
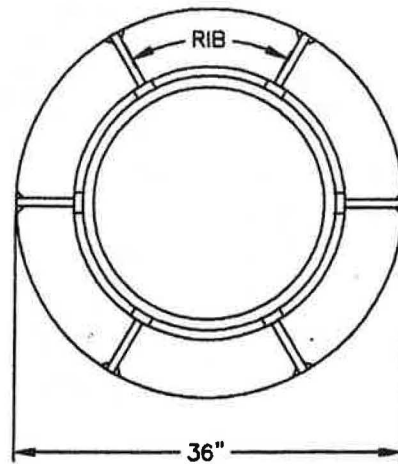
**FORCE MAIN
CLEAN-OUT
PLAN VIEW**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

MH.06
Sh 2



GENERAL NOTES:

- 1) MANHOLE FRAME TO BE NEENAH R-1642, NEENAH, WI. OR EQUAL.
- 2) WATERTIGHT MANHOLE FRAME TO BE NEENAH R-1916-F WITH BOLTS, NEENAH WIM OR EQUAL.

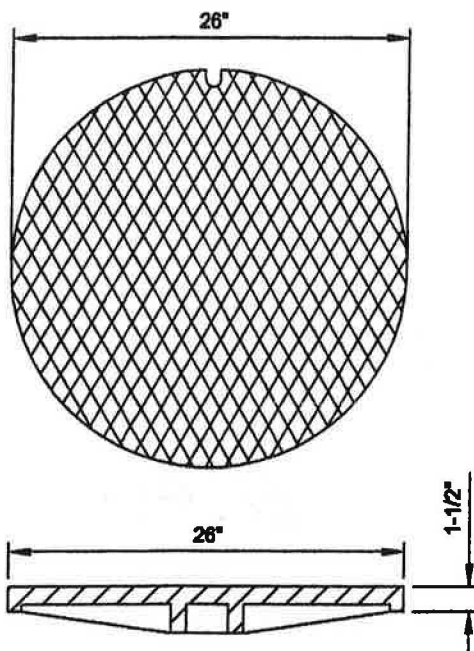
CAST IRON MANHOLE
FRAME

CITY OF PACIFIC, MISSOURI
Standard Construction Details

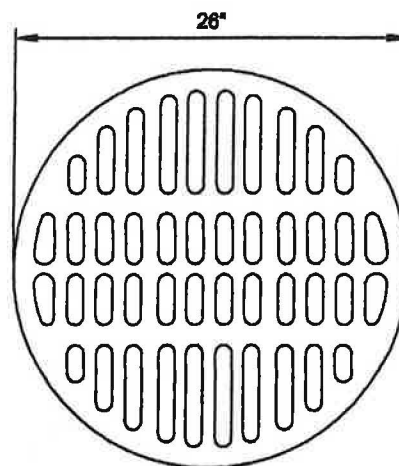
Dr. T.R.L.
Ch. R.L.B.

2000

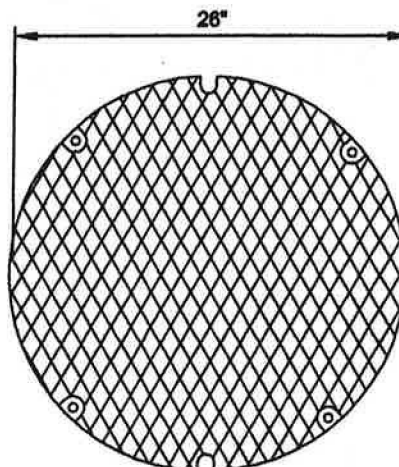
MH.07



**STANDARD CAST IRON
INLET COVER**



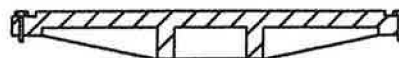
**SLOTTED CAST IRON
INLET COVER**



**WATERTIGHT CAST IRON
INLET COVER WITH BOLTS**

GENERAL NOTES:

1. STANDARD MANHOLE COVER TO BE NEENAH R-1642, NEENAH, WI, OR EQUAL.
2. SLOTTED COVER TO BE NEENAH R-2501, NEENAH, WI OR EQUAL.
3. WATERTIGHT BOLTED COVER TO BE NEENAH R-1916-F WITH BOLTS, NEENAH, WI, OR EQUAL.
4. FOR VENTED LIDS, SPECIFY COVER AND THE NUMBER OF HOLES REQUIRED FOR LID.



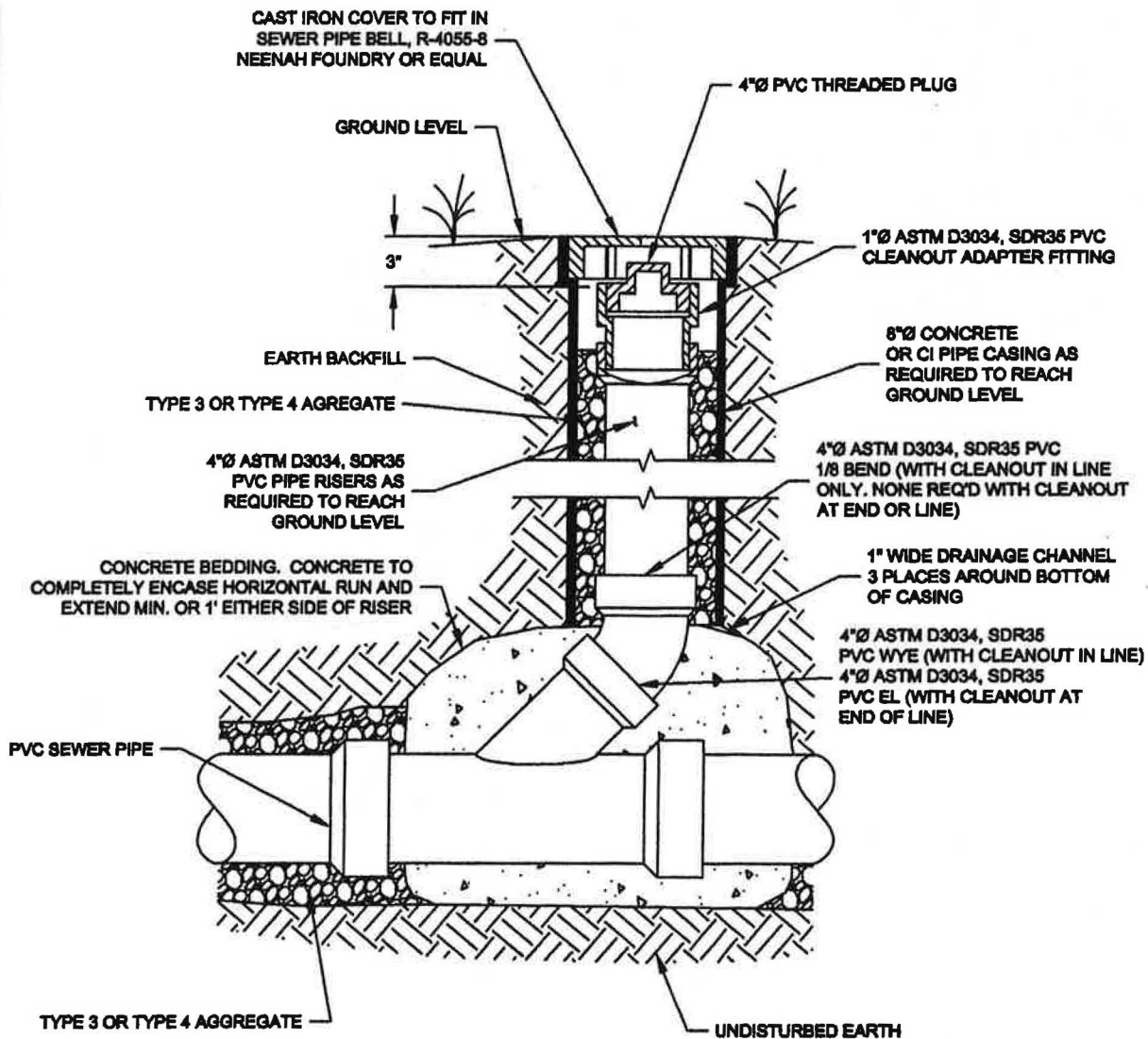
**CAST IRON COVERS
MANHOLE AND INLET**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

MH.08



**GRAVITY SEWER
CLEANOUT DETAIL**

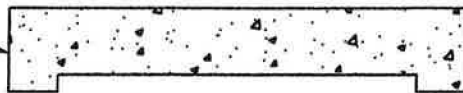
CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

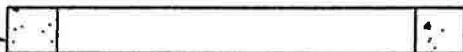
2000

MH.09

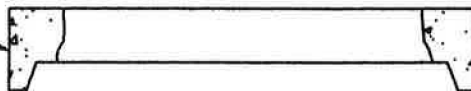
HEREFORD INLET TOP
REFER TO SW.06-SW.11



ADJUST TO GRADE WITH
STANDARD GRADE RINGS



ADAPTER RING

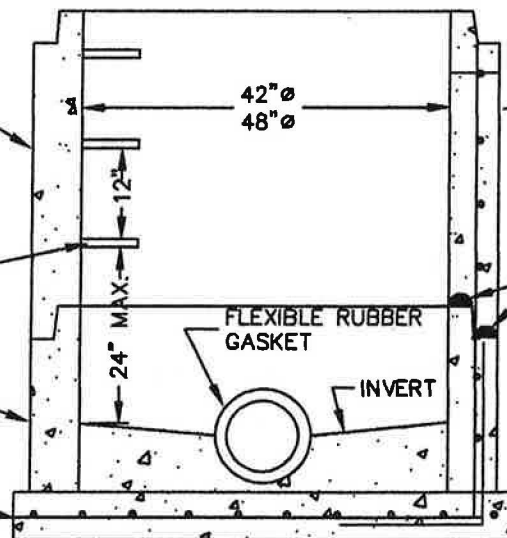


RISERS TO PLAN HEIGHT

PRESS-FIT PSI-PF STEPS
12" O.C. (TYP.)

BOTTOM ON PAD

PAD



4-1/2" WALLS
5" WALLS

2 EA. 1" BUTYL ROPE
SEALANT (TYP. ALL JOINTS)

NOTE:

INLET MANHOLE AS MANUFACTURED BY KIENSTRA,
INC., WOODRIVER, ILL, OR EQUAL

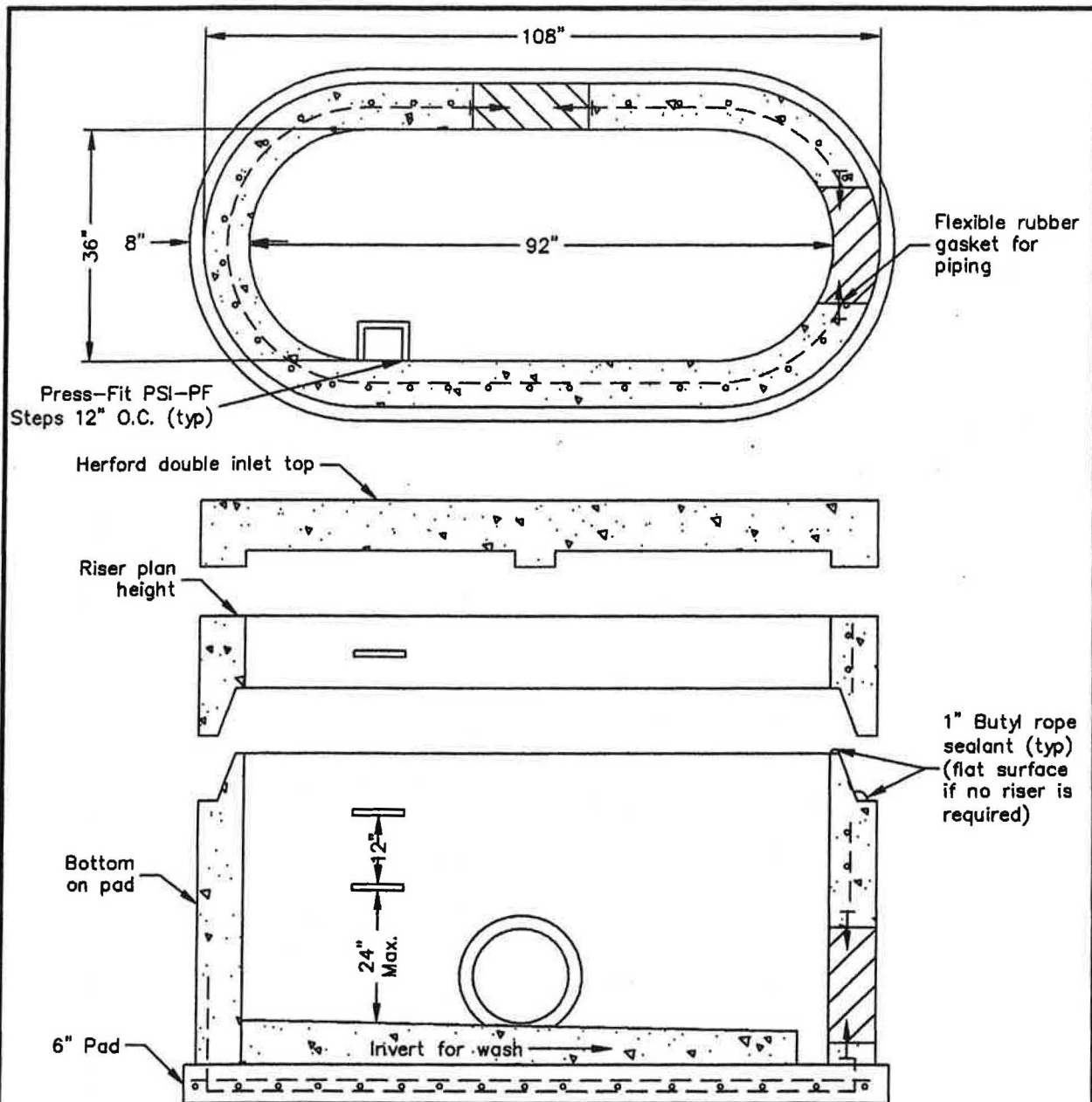
INLET MANHOLE

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

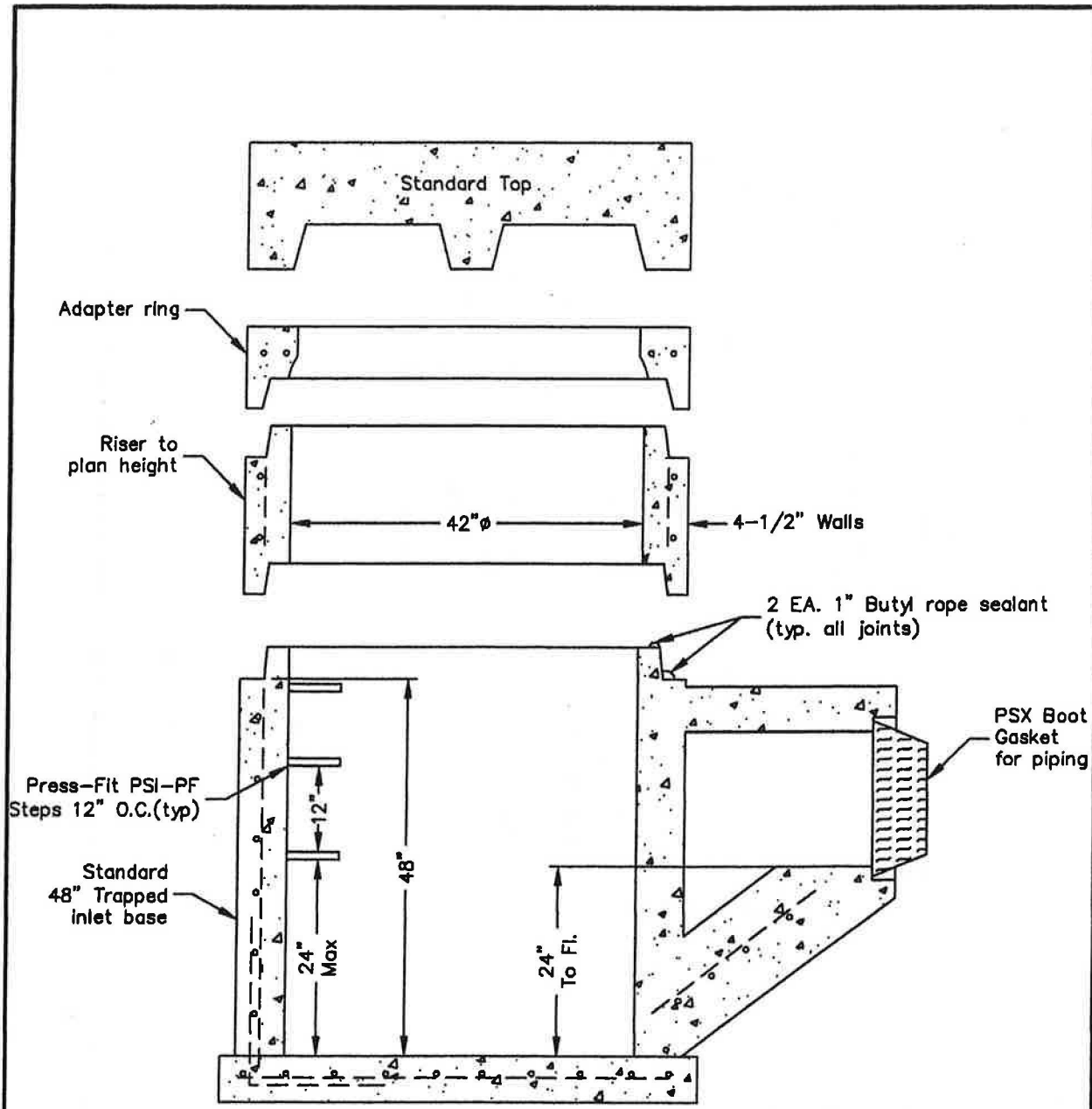
SW.02



NOTES:

- 1) Set 2 standard inlet stones in 3/4 inch mortar bed and dowel with 5/8 inch dia. 1'-0" long pins and grout.
- 2) Set the unit to base with 3/4 inch mortar bed.
- 3) This unit to be used with pre-cast base or brick base having 8 inch thick walls and inside dim dimensions conforming to the inside dimensions of the unit as indicated.
- 4) 4000 P.S.I. Required.
- 5) Inlet as manufactured by Kienstra, INC., Woodriver, ILL., or equal

PRE-CAST CONCRETE UNIT FOR STREET DOUBLE INLET	CITY OF PACIFIC, MISSOURI Standard Construction Details		
	Dr. T.R.L. Ch. R.L.B.	2000	SW.03



NOTE:

Trapped inlet as manufactured by Kienstra, INC., Woodriver, ILL., or equal.

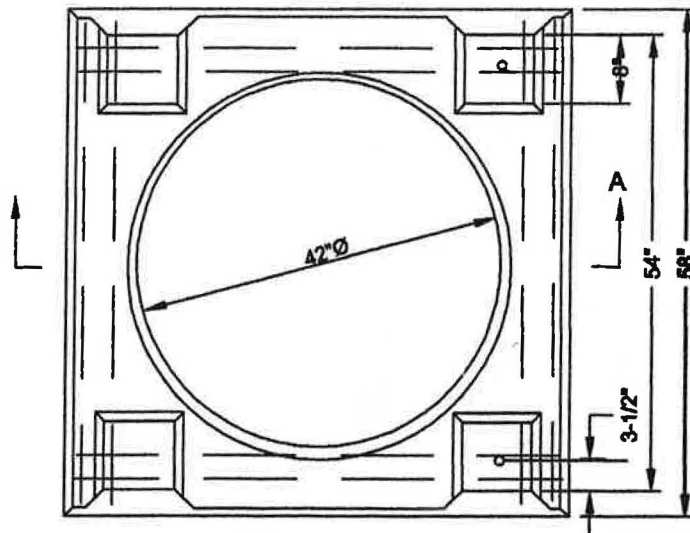
TRAPPED STREET INLET

CITY OF PACIFIC, MISSOURI
Standard Construction Details

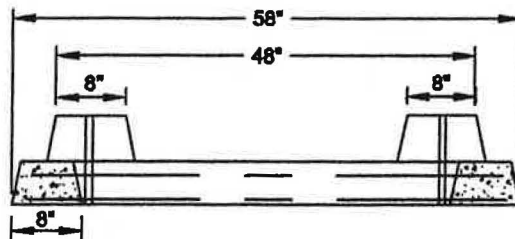
Dr. T.R.L.
 Ch. R.L.B.

2000

SW.04



PLAN



SECTION A-A

NOTES:

1. 4000 P.S.I. CONCRETE REQUIRED.
2. THIS UNIT TO BE USED WITH, 42" I.D., BRICK OR CONCRETE BASE.
3. INLET TOP AS MANUFACTURED BY KIENSTRA, INC., WOODRIVER, ILL., OR EQUAL.

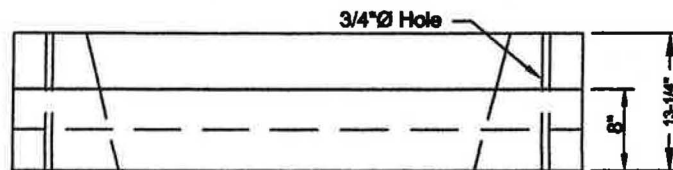
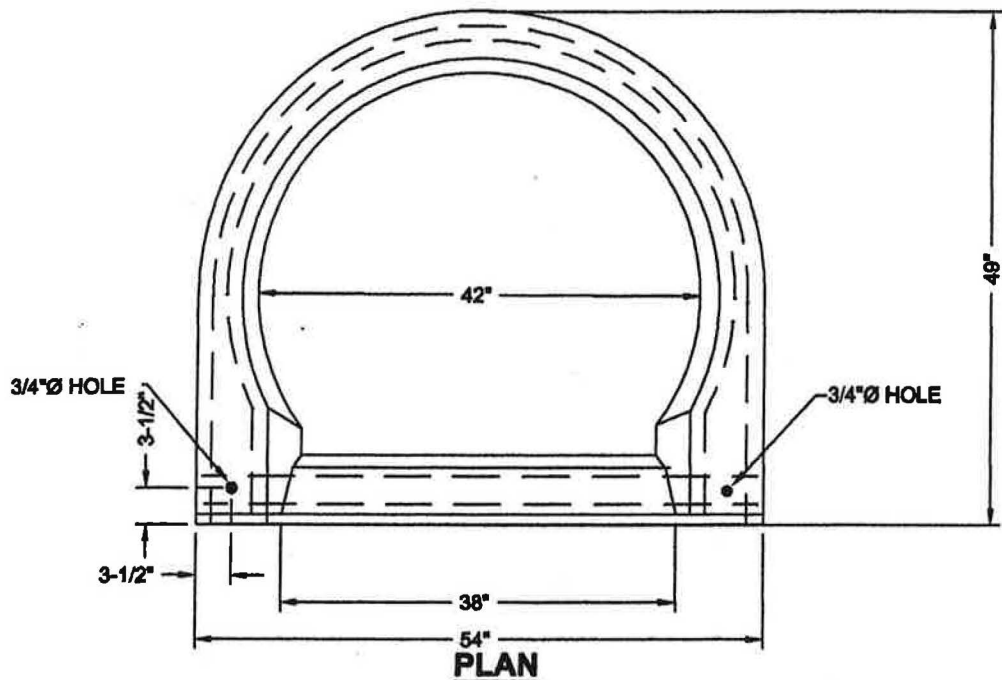
AREA INLET TOP

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
 Ch. R.L.B.

2000

SW.06



NOTES:

1. SET STANDARD INLET STONE IN 3/4 INCH MORTAR BED AND DOWEL WITH 5/8 INCH DIA. 1'-0" LONG PINS AND GROUT.

2. RAISE TO FINAL GRADE WITH COURSES OF BRICK OR PRE-CAST CONCRETE GRADE RINGS AND 3/4 INCH MORTAR BED.

3. THIS UNIT IS TO BE USED WITH 42 INCH I.D., POURED IN PLACE CONCRETE OR BRICK BASE.

4. 4000 P.S.I. CONCRETE REQUIRED.

5. CURB INLET AS MANUFACTURED BY KIENSTRA, INC., WOODRIVER, ILL., OR EQUAL.

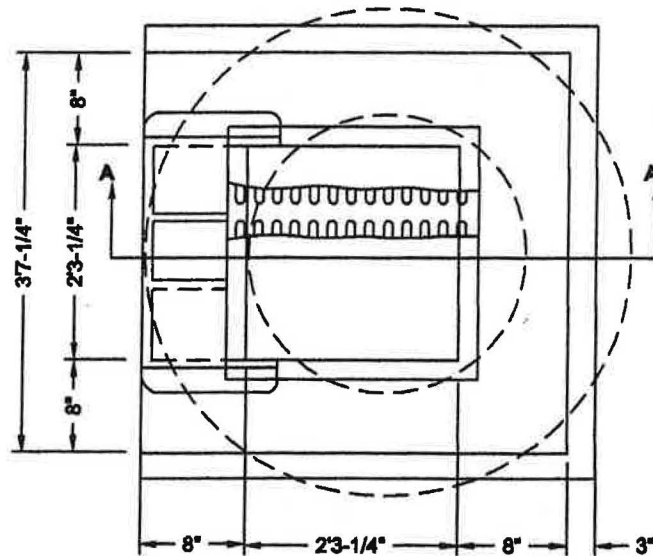
PRE-CAST CURB INLET

CITY OF PACIFIC, MISSOURI
Standard Construction Details

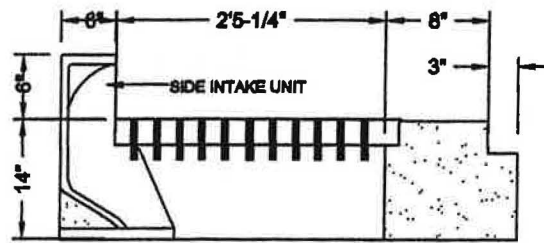
Dr. T.R.L.
Ch. R.L.B.

2000

SW.07



PLAN VIEW



SECTION A-A

NOTE:

GRATE INLET AS MANUFACTURED BY KIENSTRA, INC.,
WOODRIVER, ILL., OR EQUAL.

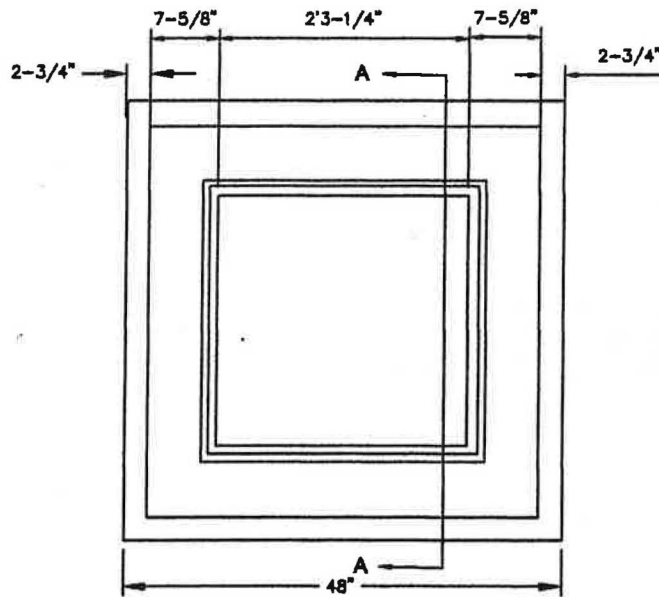
**2 GRATE INLET
SIDE INTAKE UNIT**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

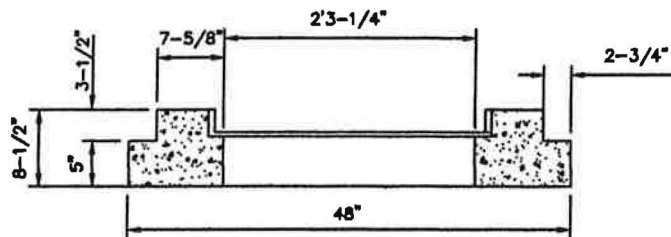
Dr. T.R.L.
Ch. R.L.B.

2000

SW.08



PLAN



SECTION A-A

NOTES:

1. INLET TOP AS MANUFACTURED BY KIENSTRA, INC., WOODRIVER, ILL., OR EQUAL.
2. SEE SW.10 FOR GRATE DETAIL.

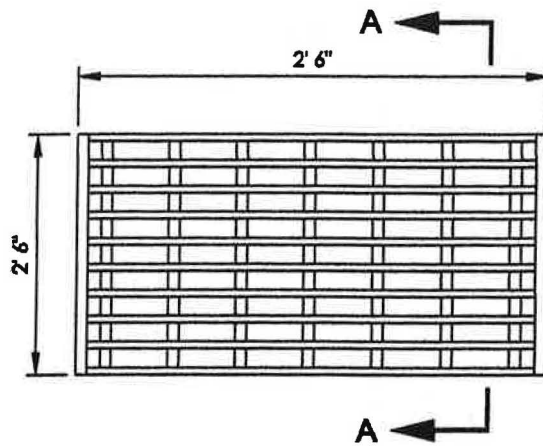
2 GRATE INLET TOP

CITY OF PACIFIC, MISSOURI
Standard Construction Details

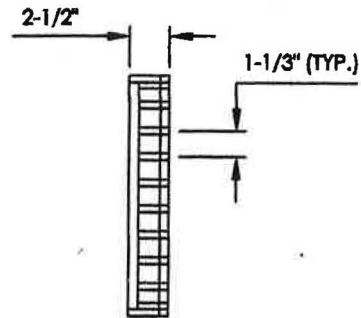
Dr. T.R.L.
Ch. R.L.B.

2000

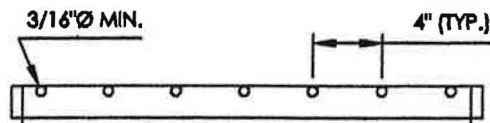
SW.09



PLAN



SECTION A-A



- FINISH - ASPHALTIC 10 MIL. COATING
- MATERIAL - MILD CARBON STEEL - ASTM A 569
- CAPACITY - H2O LOADING
- WEIGHT - 65# MIN.
- TOLERANCES - ALL DIMENSIONS $\pm 1/8"$
- IDENTIFICATION - THE MANUFACTURER MUST PLACE HIS NAME OR MARK ON EACH UNIT FOR THE PURPOSE OF IDENTIFICATION

NOTES:

1. STEEL GRATE AS MANUFACTURED BY KIENSTRA, INC., WOODRIVER, ILL, OR EQUAL.
2. NEENAH NO. R-4573 CAST IRON GRATE MAY BE SUBSTITUTED FOR STEEL GRATE, NEENAH, WI, OR EQUAL.

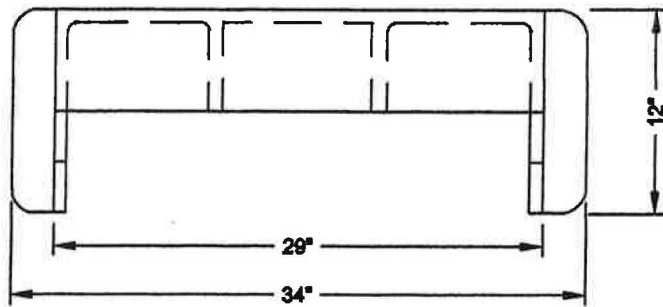
DETAIL OF STEEL GRATE

CITY OF PACIFIC, MISSOURI
Standard Construction Details

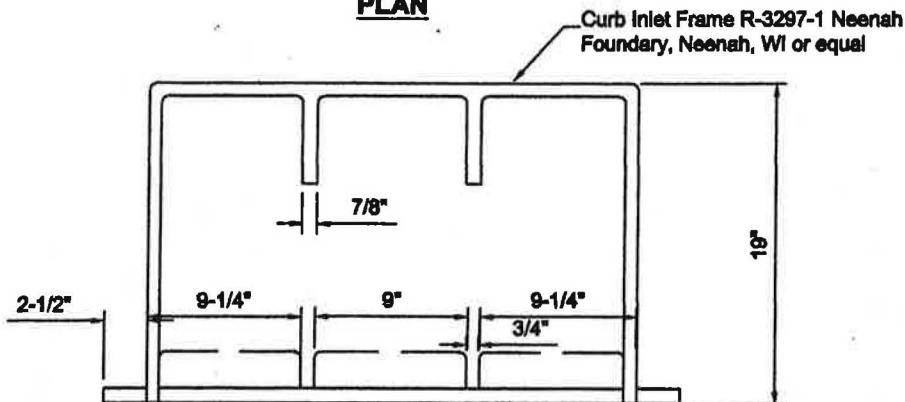
Dr. T.R.L.
Ch. R.L.B.

2000

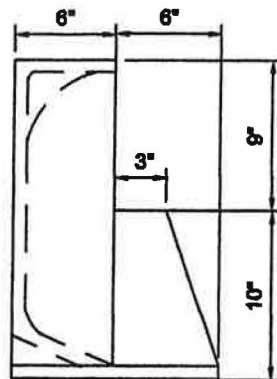
SW.10



PLAN



ELEVATION



END VIEW

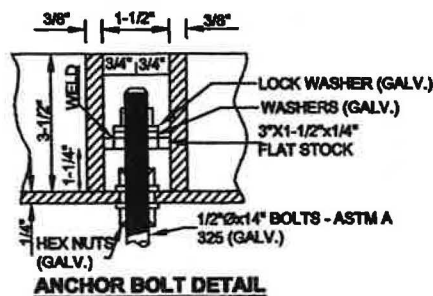
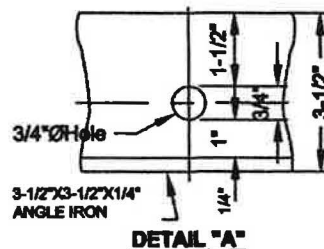
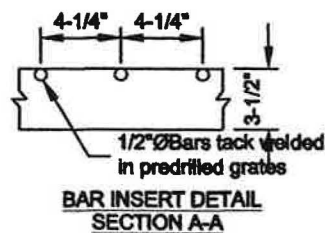
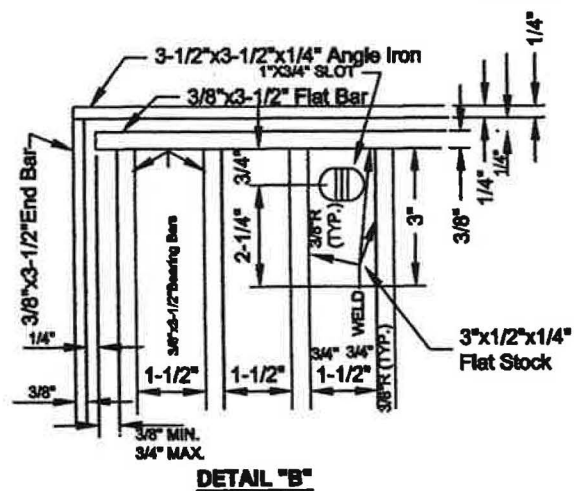
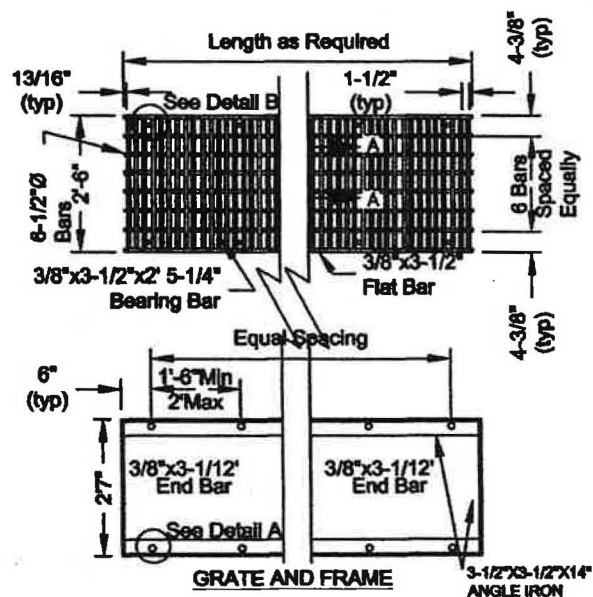
**CAST IRON
SIDE INTAKE UNIT
FOR GRATED INLETS**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

SW.11



GENERAL NOTES:

- 1) When bolts are cut in the field, threads must be cleaned to permit the final nut to run freely on the bolt.
- 2) All joints shall be continuous welded.
- 3) Steel grates and frames must be painted.
- 4) Bolts, nuts, and washers shall be hot-dip galvanized in accordance with the requirements of ASTM A123.
- 5) Grate must be fixed to frames prior to pouring adjacent pavement approaches.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

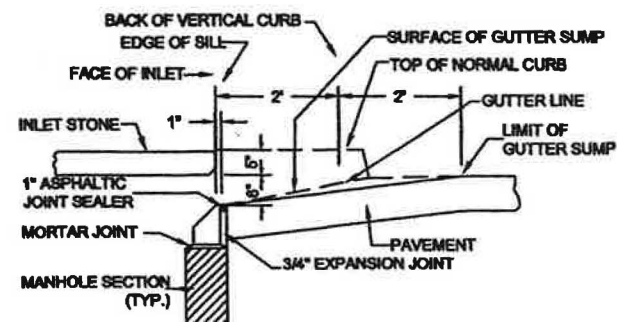
STANDARD CONSTRUCTION DETAILS

GRATES AND BEARING PLATES

Dr. G.P.L.	2000	SW.12
Ch. R.L.B.		

FRONT VIEW OF GUTTER SUMP
VERTICAL CURB

PLAN VIEW OF GUTTER SUMP
VERTICAL CURB



SECTION A-A

GENERAL NOTES:

1. IF INLET STONE ENCROACHES ON SIDEWALK, OUTLINE LIMITS OF SAID ENCROACHMENT WITH EXPANSION JOINT MATERIAL AND POUR SIDEWALK FLUSH WITH INLET STONE.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

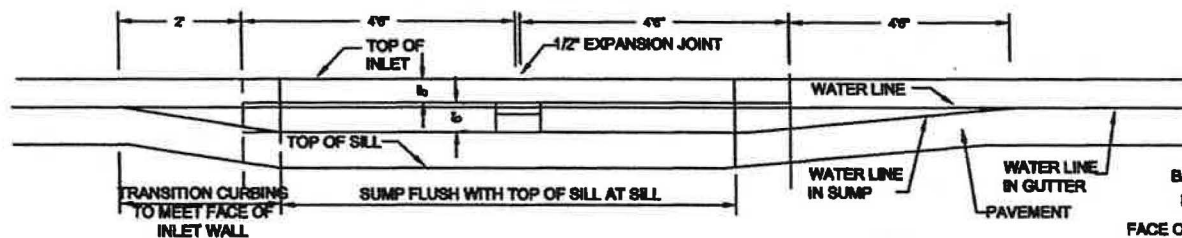
SEWER CONSTRUCTION DETAILS

STREET INLET SUMPS

Dr. T.R.L.
Ch. R.L.B.

2000

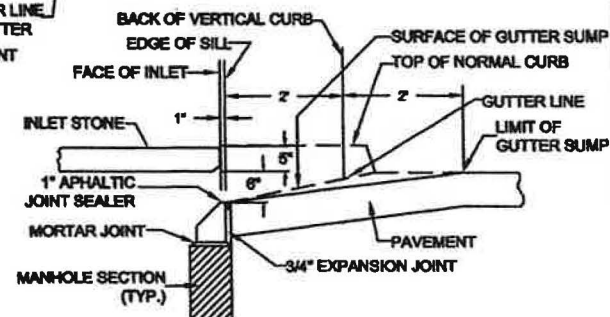
SW.18
Sh 1



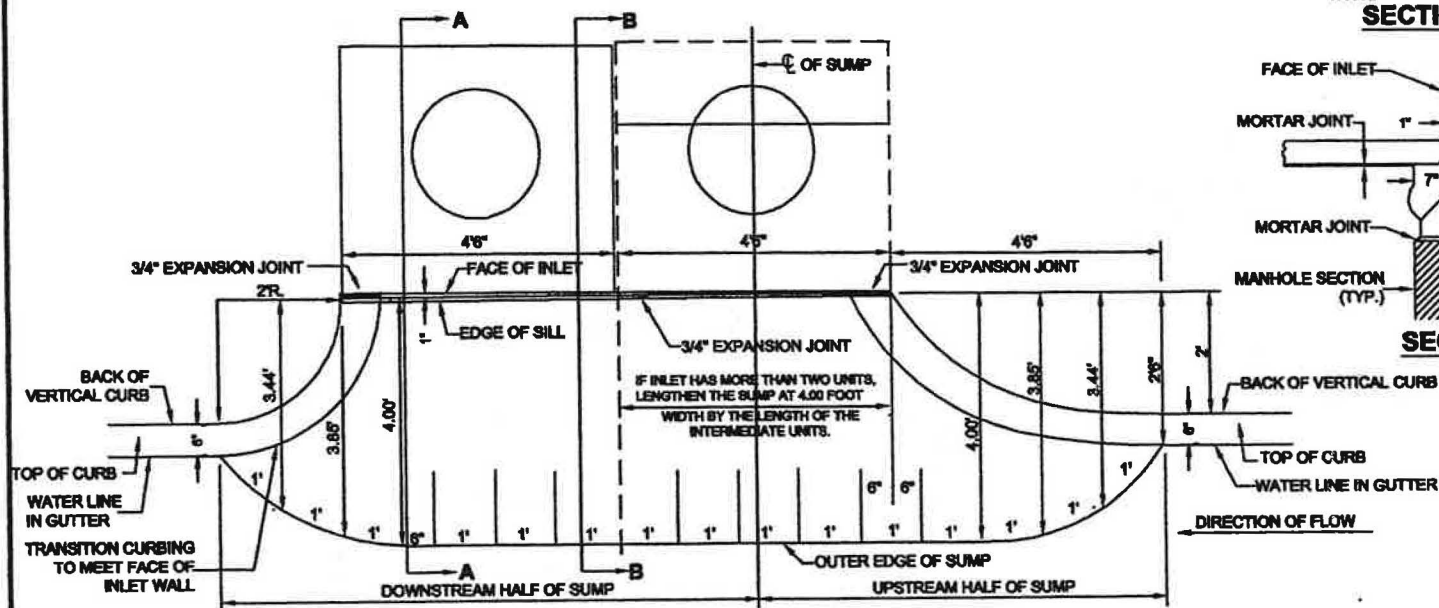
**FRONT VIEW OF GUTTER SUMP FOR MULTIPLE UNIT
VERTICAL CURB**

GENERAL NOTES:

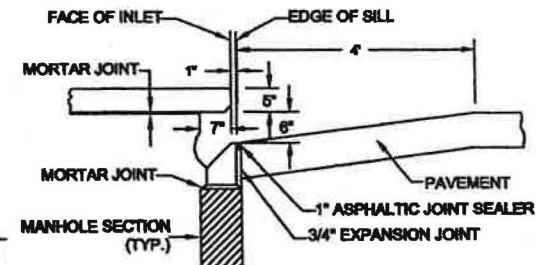
1. IF INLET STONE ENCLOSES ON SIDEWALK
OUTLINE LIMITS OF SAID ENCROACHMENT WITH
EXPANSION JOINT MATERIAL AND POUR
SIDEWALK FLUSH WITH INLET STONE.



SECTION A-A



**PLAN VIEW OF GUTTER SUMP FOR MULTIPLE UNIT
VERTICAL CURB**



SECTION B-B

CITY OF PACIFIC, MISSOURI
Standard Construction Details

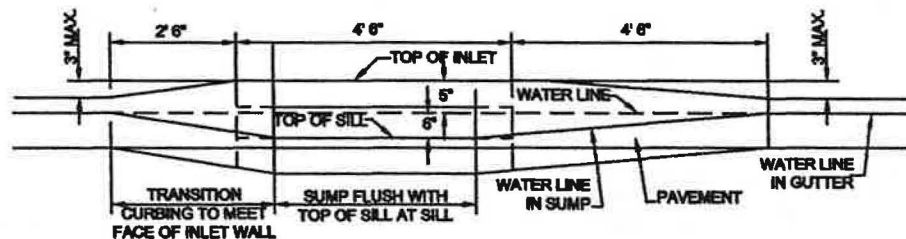
SEWER CONSTRUCTION DETAILS

STREET INLET SUMPS

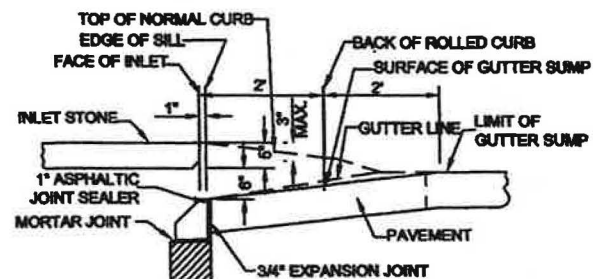
Dr. T.R.L.
Ch. R.L.B.

2000

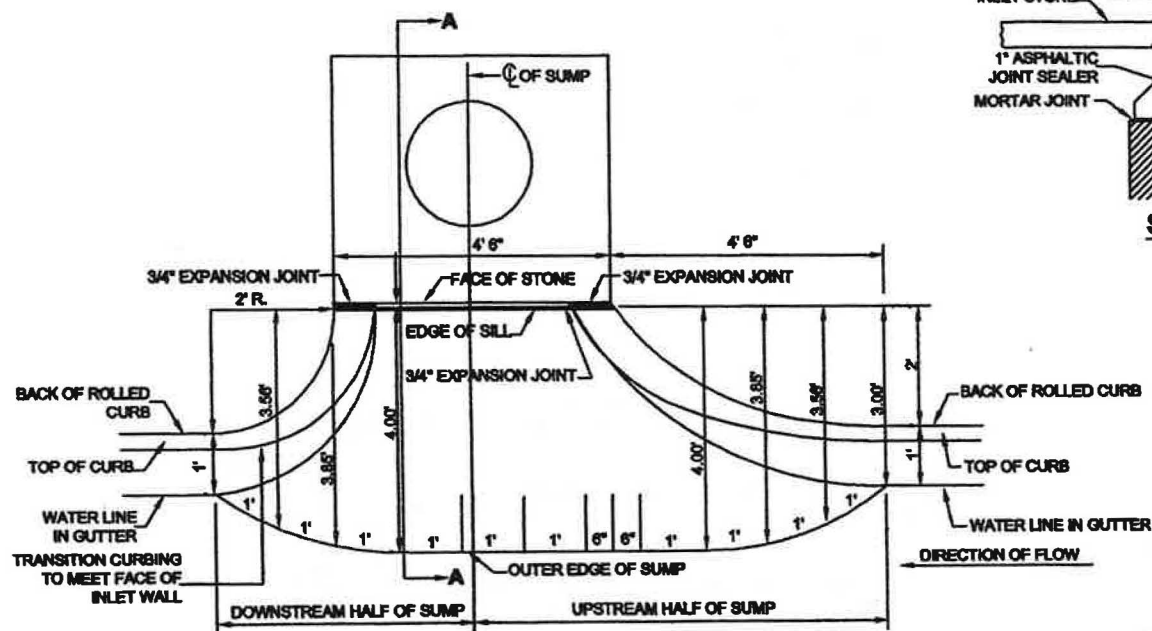
SW.18
Sh 2



**FRONT VIEW OF GUTTER SUMP
ROLLED CURB**



SECTION A-A



**PLAN VIEW OF GUTTER SUMP
ROLLED CURB**

GENERAL NOTES:

1. IF INLET STONE ENCSROACHES ON SIDEWALK, OUTLINE LIMITS OF SAID ENCSROACHMENT WITH EXPANSION JOINT MATERIAL AND POUR SIDEWALK FLUSH WITH INLET STONE.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

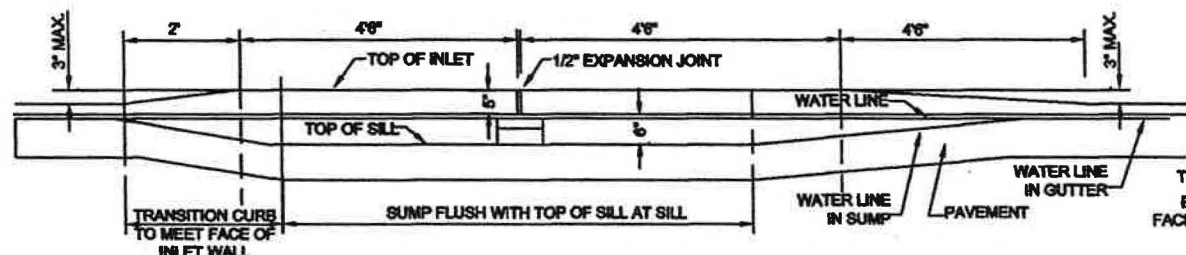
SEWER CONSTRUCTION DETAILS

STREET INLET SUMPS

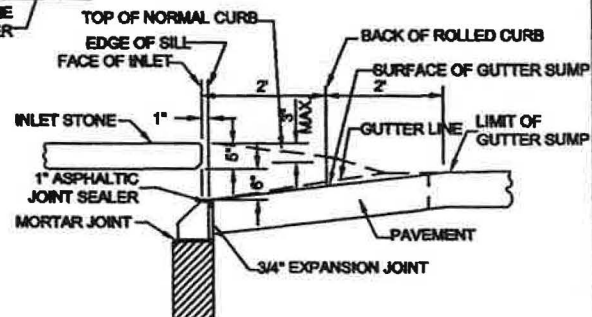
Dr. T.R.L.
Ch. R.L.B.

2000

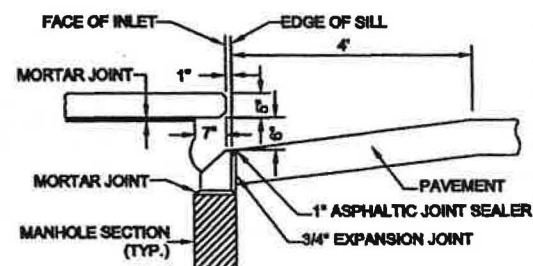
SW.18
Sh 3



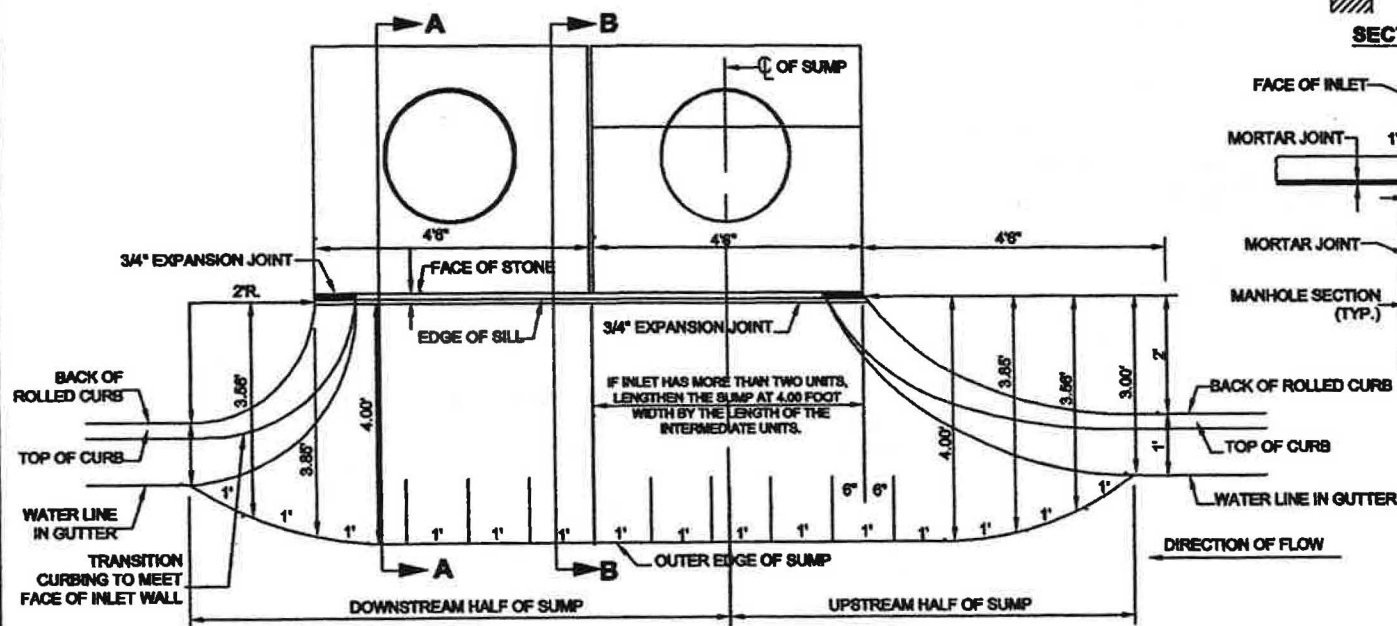
**FRONT VIEW OF GUTTER SUMP FOR MULTIPLE UNIT
ROLLED CURB**



SECTION A-A



SECTION B-B



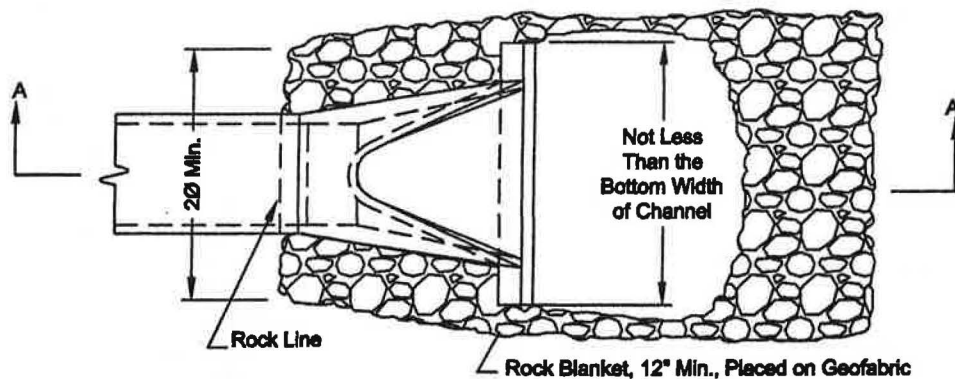
**PLAN VIEW OF GUTTER SUMP FOR MULTIPLE UNIT
ROLLED CURB**

GENERAL NOTES:

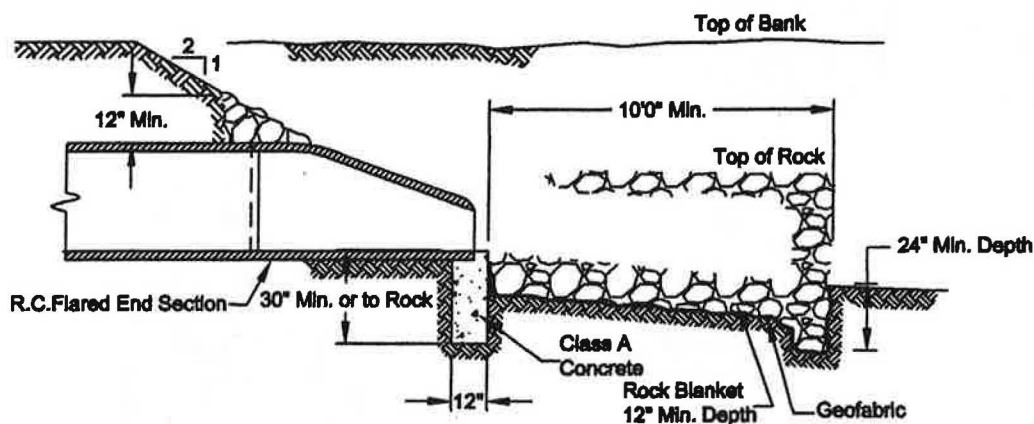
1. IF INLET STONE ENCLOSES ON SIDEWALK, OUTLINE LIMITS OF SAID ENCROACHMENT WITH EXPANSION JOINT MATERIAL AND POUR SIDEWALK FLUSH WITH INLET STONE.

CITY OF PACIFIC, MISSOURI
Standard Construction Details
SEWER CONSTRUCTION DETAILS
STREET INLET SUMPS

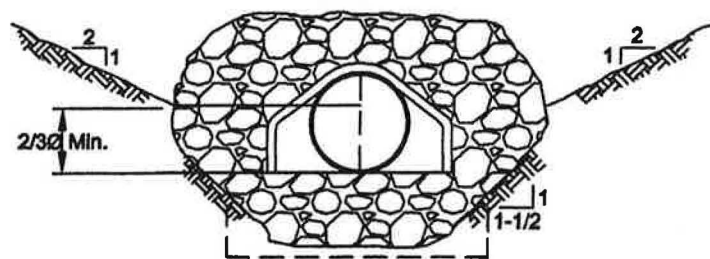
Dr. T.R.L. Ch. R.L.B.	2000	SW.18 Sh 4
--------------------------	------	---------------



PLAN VIEW



SECTION A-A



END VIEW

NOTES:

1. To be used at intake and discharge end of pipe. Grade of rock blanket to be adjusted accordingly.

2. Geofabric to be Mirafi 140N nonwoven fabric as manufactured by Nicolson Mirafi Group, Norcross, GA, or equal.

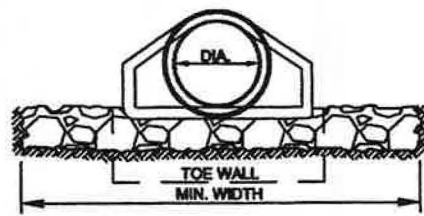
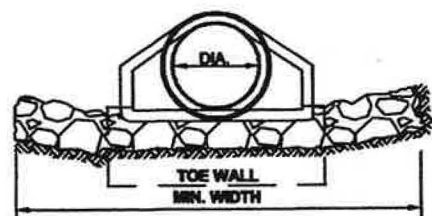
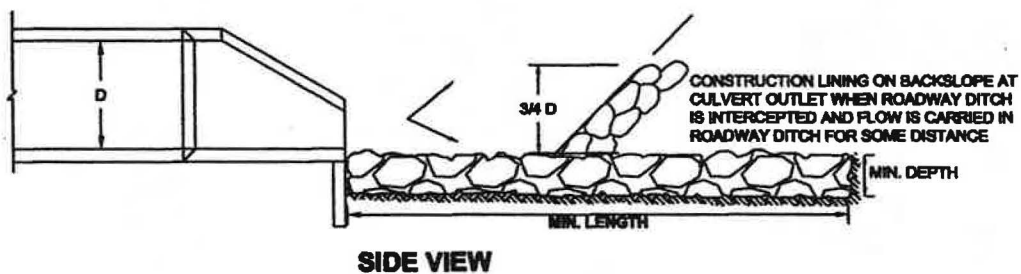
FLARED END SECTION

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

SW.19



ROCK LINING FOR CULVERT OUTLETS

CULVERT SIZE, DIA. INCH	MINIMUM DEPTH AND WIDTH FEET	MINIMUM LENGTH FEET	ROCK LINING CU. YD.	EQUIVALENT PIPE ARCH CULVERT (APPROX.)	EQUIVALENT CONC. BOX CULV. (APPROX.)
18	1 x 4	12	2	-	-
24	1 x 6	14	3	-	2' x 1-1/2'
30	1 x 7	18	4	B-5	2' x 2'
36	1.5 x 9	18	9	B-6	3' x 2'
42	2 x 10	20	15	B-7	3' x 3'
48	2 x 12	20	18	B-8	4' x 3'
54	2 x 13.5	22	22	B-9	4' x 4'
60	2 x 16	26	28	B-10	5' x 4'
66	2 x 18	26	33	B-11	5' x 6'
72	2 x 20	30	44	B-12	5' x 6'
84	2.5 x 25	35	81	-	6' x 6'
96	2.5 x 30	40	111	-	7' x 7'
108	3 x 32	40	142	-	6' x 6'

GENERAL NOTES:

THE DIMENSIONS SHOWN IN THE TABLE CAN BE APPLIED TO BOX OR ARCH CULVERTS OF EQUIVALENT WATERWAY AREA.

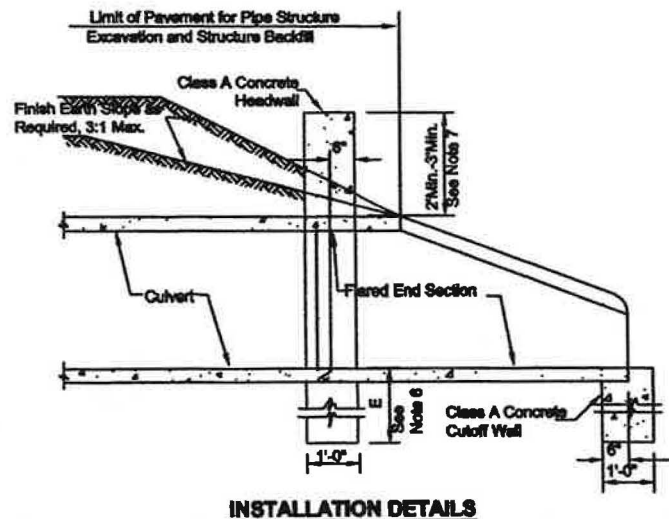
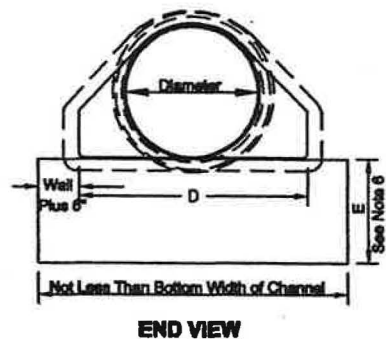
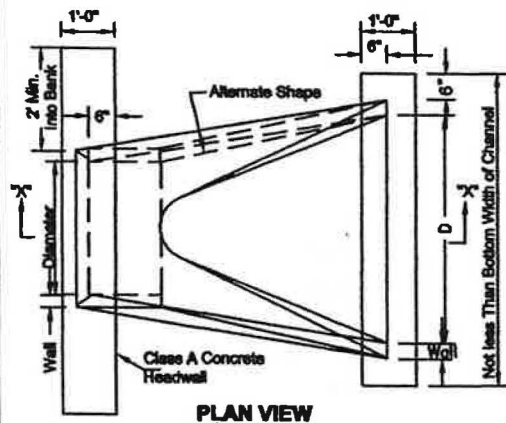
CITY OF PACIFIC, MISSOURI
Standard Construction Details

**ROCK LINING
FOR CULVERT OUTLET**

Dr. T.R.L.
Ch. R.L.B.

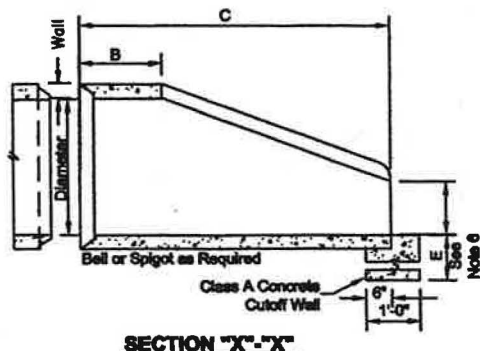
2000

SW.20



DIMENSIONS						
Dia.	Well	A	B(MIN)	C(MIN)	D	E
12"	2'	4"	4'-0"	6"	2'-0"	SEE NOTE 6
15"	2'-1/4"	6"	3'-10"	6"	2'-6"	
18"	2'-1/2"	6"	3'-10"	6"	3'-0"	
21"	2'-3/4"	6"	3'-2"	6"	3'-6"	
24"	3'	8'-1/2"	2'-6"	6"	4'-0"	
27"	3'-1/4"	10'-1/2"	2'-1"	6"	4'-6"	
30"	3'-1/2"	1'-0"	1'-7"	6"	5'-0"	
36"	4'	1'-3"	2'-10"	6"	6'-0"	
42"	4'-1/2"	1'-6"	2'-11"	6"	6'-6"	
48"	5'	2'-0"	2'-2"	6"	7'-0"	
54"	5'-1/2"	2'-3"	2'-11"	6"	7'-6"	
60"	6'	2'-6"	3'-3"	6"	8'-0"	
66"	6'-1/2"	2'-0"	1'-9"	6"	8'-6"	

ADJONED PIPE DIAMETER INCHES	BARREL SECTION REINFORCEMENT			FLARE SECTION REINFORCEMENT (ONE LAYER) IN CTR OF WALL	
	CIRCULAR		ELLIPTICAL	AREA OF LONGITU- DINALS Sq In/Lin Ft	AREA OF TRANS- VERSE Sq In/Lin Ft
	INNER CAGE Sq In/ Lin Ft	OUTER CAGE Sq In/ Lin Ft			
12"	0.07	-	-	0.048	0.048
15"	0.07	-	-	0.054	0.054
18"	0.07	-	0.07	0.060	0.060
21"	0.07	-	0.07	0.066	0.066
24"	0.07	-	0.07	0.072	0.072
27"	0.13	-	0.11	0.078	0.078
30"	0.14	-	0.12	0.084	0.084
36"	0.12	0.09	0.13	0.096	0.096
42"	0.15	0.12	0.17	0.108	0.108
48"	0.18	0.14	0.20	0.120	0.120
54"	.022	0.16	0.24	0.132	0.132
60"	0.26	0.19	0.28	0.144	0.144
66"	0.31	0.23	0.34	0.156	0.156



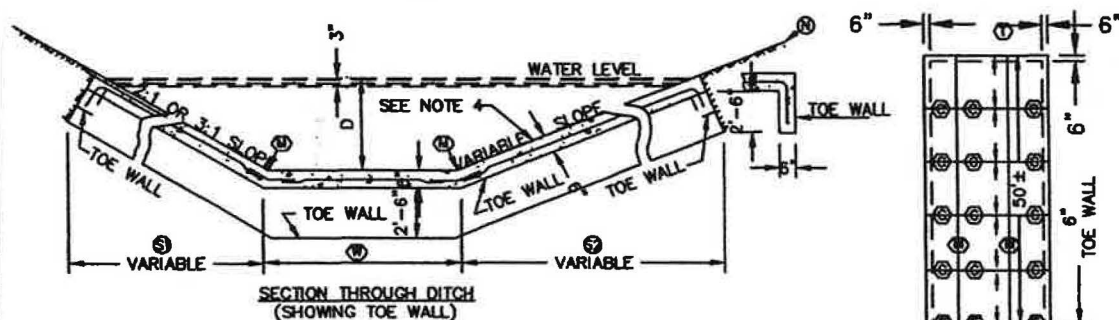
GENERAL NOTES

1. Do not scale drawing. Follow Dimensions.
2. Slight variations in both shape and dimensions from those shown may be accepted if approved by Engineer.
3. Not more than three lift holes may be drilled or cast in the End Section for handling and laying.
4. Lift lugs or bars will be permitted in precast Cutoff Walls.
5. Cutoff Wall may be cast-in-place or precast.
6. Cutoff Wall and Headwall to be constructed a minimum of 2 feet upstream or a minimum of 3 feet downstream or to rock.
7. For more than 3'-0" provide detail of Reinforced Concrete Headwall, Wingwalls, Apron and Cutoff Wall.
8. For entrance culvert installations, concrete headwall height shall not exceed 1'-0" above top of culvert top of culvert pipe.

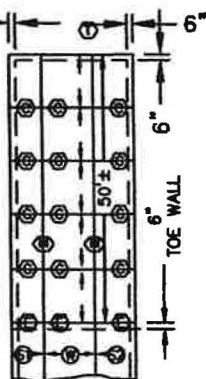
CITY OF PACIFIC, MISSOURI
Standard Construction Details

FLARED END SECTION
(PRECAST CONCRETE)

Dr. T.R.L. 2000 SW.21
Ch. R.L.B.



FLAT BOTTOM TYPE

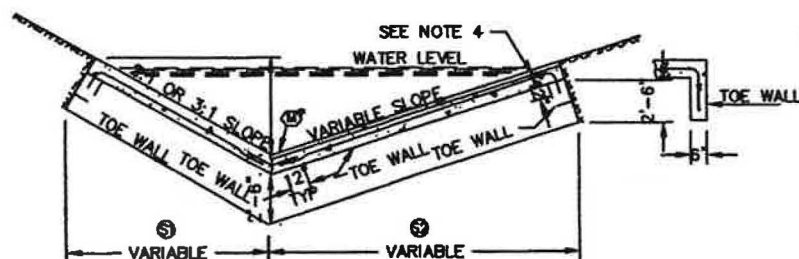


PLAN

- ⑩ CONTRACTION JOINT—SEE DETAIL
 ⑪ 1/2" PREFORMED FIBER JOINT TO BE CONSTRUCTED AS TRANSVERSE JOINT AS APPROXIMATELY 50 FOOT INTERVALS
 ⑫ KEY JOINT—SEE DETAIL— TO BE CONSTRUCTED AS A LONGITUDINAL JOINT IN FLAT BOTTOM TYPE DITCHES.
 ⑬ TOE WALL SHALL BE CONSTRUCTED AT OUTLET AND INLET END OF PAVED DITCHES AND AT 50 FOOT MAXIMUM SPACING
 ⑭ THE WIDTH OF THE STEEPER SIDEWALL OF ALL DITCHES.
 ⑮ THE WIDTH OF THE FLATTER SIDEWALL OF ALL DITCHES.
 ⑯ VARIABLE DISTANCE
 ⑰ WIDTH OF THE BOTTOM OF A FLAT BOTTOM DITCH.
 ⑱ SHOULDER FINISHED GRADE OF NATURAL GROUND.

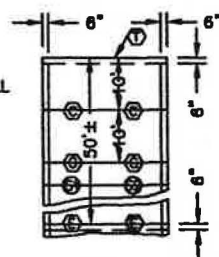
GENERAL NOTES:

- 1) DO NOT SCALE DRAWING.
 2) REINFORCED AND TIE BARS SHALL BE REQUIRED AS SHOWN ON THE PLANS.
 3) THE CONTRACTION JOINT FOR THE GUTTER SHALL BE CONSTRUCTED TO A MINIMUM WIDTH OF 3/8 INCHES TO A DEPTH OF 1/4 GUTTER THICKNESS AT INTERVALS OF 30 FEET.
 4) MINIMUM #4 BARS @ 15 INCH CTR. BOTH WAYS, CENTERED IN THE SLAB.

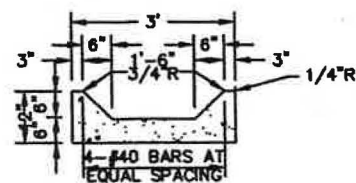
SECTION THROUGH DITCH
(SHOWING TOE WALL)

*USE ⑩ JOINT ONLY IF "V" DITCH IS CONSTRUCTED IN TWO SEPARATE POURS

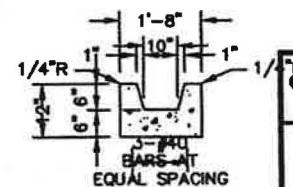
V TYPE



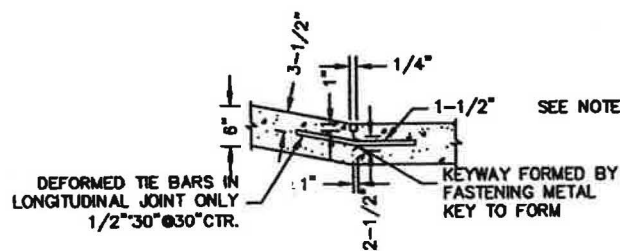
PLAN



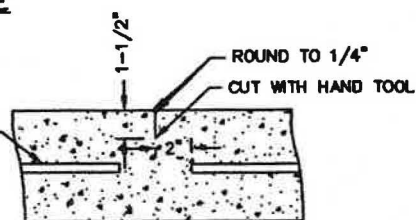
TYPE-A



TYPE-B



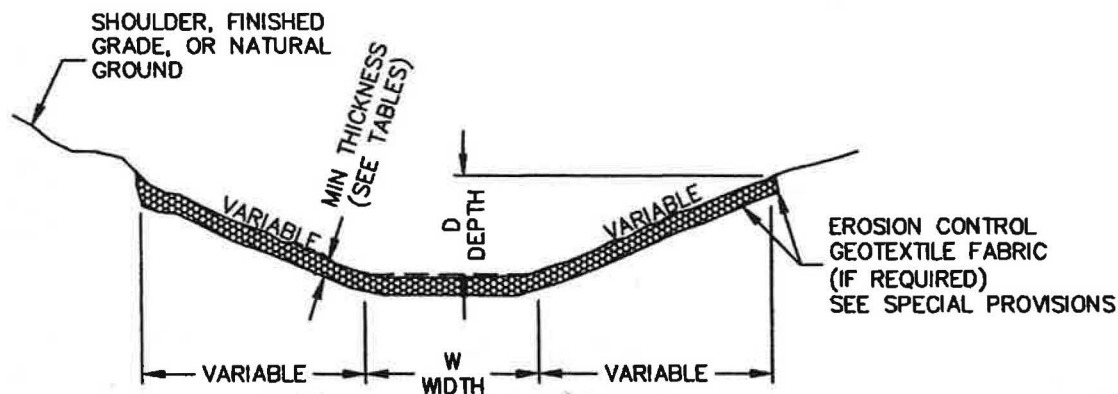
KEY JOINT DETAIL

DETAILS OF
CONTRACTION JOINT

CITY OF PACIFIC, MISSOURI
Standard Construction Details

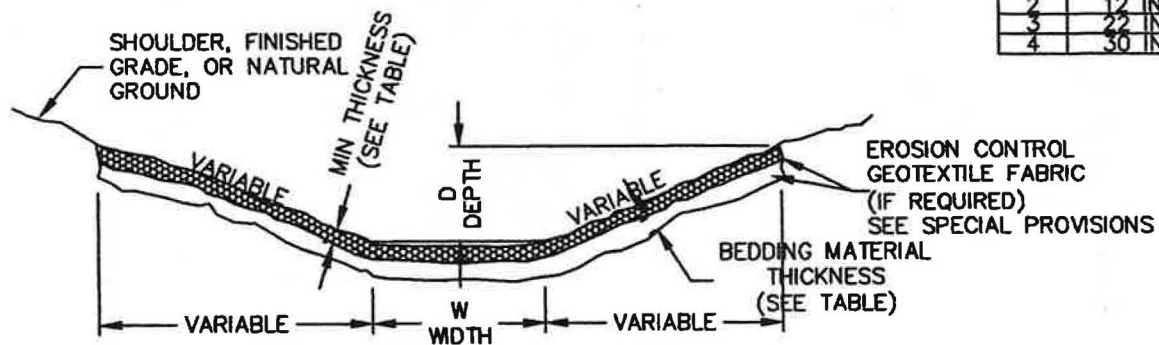
PAVED DITCHES
AND GUTTERS

Dr. T.R.L. 2000 SW.22
Ch. R.L.B.



FLAT BOTTOM DITCH
WITHOUT BEDDING MATERIAL

TYPE	ROCK DITCH	BEDDING MATERIAL
	LINER MIN THICKNESS	MIN. THICKNESS
1	8 IN.	--
2	12 IN.	--
3	22 IN.	8 IN.
4	30 IN.	12 IN.



FLAT BOTTOM DITCH
WITHOUT BEDDING MATERIAL

TYPICAL DITCH LINER DETAILS

CITY OF PACIFIC, MISSOURI
Standard Construction Details

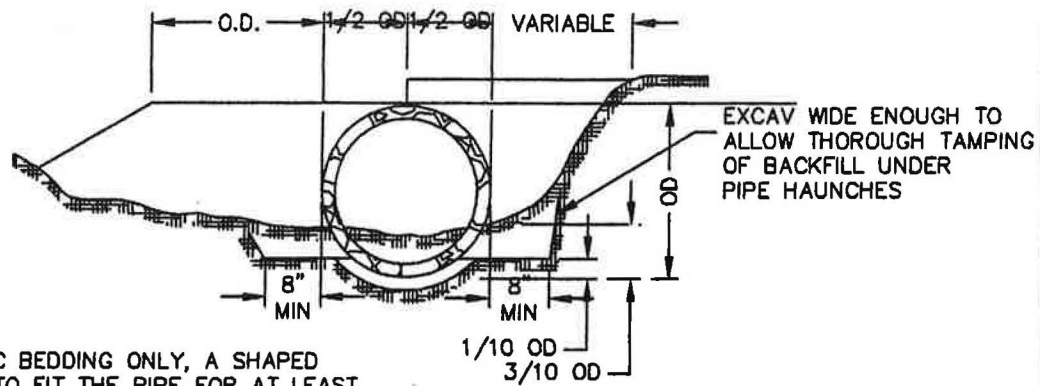
ROCK DITCH LINER

Dr. T.R.L.
Ch.R.L.B.

2000

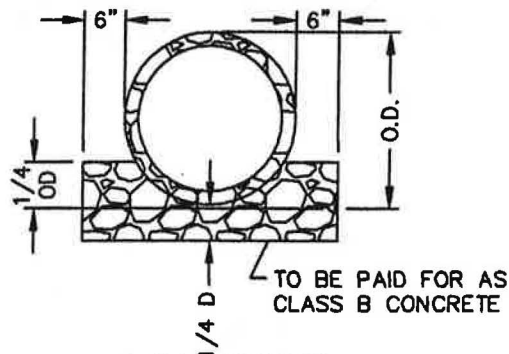
SW.23

TOP OF PIPE ABOVE GROUND LINE ——— TOP OF PIPE BELOW GROUND LINE
ROADBED GRADE—TOP OF FILL

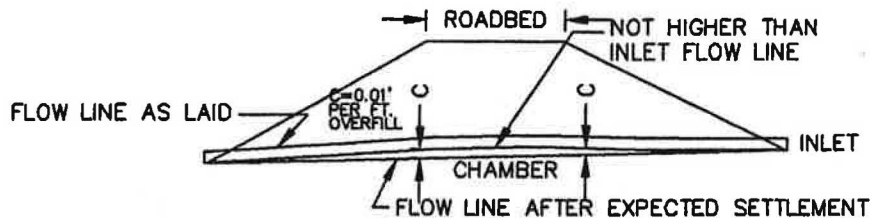


NOTE:
FOR CLASS C BEDDING ONLY, A SHAPED
EARTH BED TO FIT THE PIPE FOR AT LEAST
10D SHALL BE REQUIRED

CLASS B & C BEDDING



CLASS A BEDDING REINFORCED CONCRETE PIPE CULVERTS



NOTE:
ON YIELDING SOIL, PIPE CULVERTS SHOULD BE PLACED ON A
CAMBERED FLOW LINE. THE AMOUNT OF CAMBER WILL VARY
WITH SOIL CONDITION AND SHALL BE SPECIFIED ON THE DESIGN
PLANS.

TYPICAL CAMBERED FLOW LINE

CULVERT INSTALLATION
METHODS

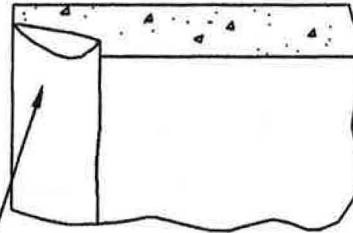
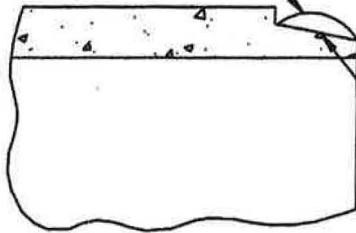
CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

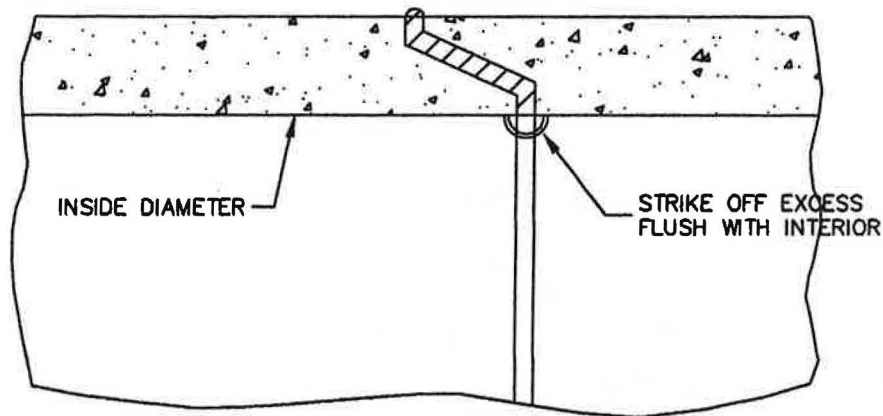
SW.24
Sh 2

APPLY COLD MIX COMPOUND AFTER DRYING AND HARDENING OF PRIMER TO A SUITABLE SURFACE WHICH WILL HOLD COMPOUND WITHOUT SAGGING, AND NOT SOONER THAN 3 HOURS AFTER PRIMER HAS BEEN APPLIED



FOR USE OF COLD-MIXED JOINTING COMPOUNDS WITH TONGUE-AND-GROOVE CONCRETE PIPE. USE ONLY WHEN RUBBER-TYPE OR PREMOLDED BITUMINOUS OR SPECIAL GASKETS ARE NOT REQUIRED.

APPLY APPROVED PRIMER TO JOINING PIPE SURFACES. AMOUNT OF COMPOUND TO BE APPLIED TO JOINING SURFACE SHALL BE SUFFICIENT TO COMPLETELY FILL THE JOINT. USE OF AN APPROVED PREFORMED COMPOUND IS PERMITTED.



INSIDE WIDTH OF JOINT	→	←	FOR STRAIGHT ALIGNMENT ONLY
1-1/4" MAX	→	←	FOR INSIDE DIA. 48" AND LARGER
1" MAX	→	←	FOR INSIDE DIA. 24" TO 45" INCLUSIVE
3/4" MAX	→	←	FOR INSIDE DIA. 12" TO 21" INCLUSIVE

50% MAXIMUM INCREASE PERMITTED ONLY ON CURVED ALIGNMENTS

TONGUE & GROOVE
CONCRETE PIPE JOINT

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

SW.25

TABLE OF DIMENSIONS

TABLE OF DIMENSIONS

TABLE OF DIMENSIONS									
SIZE OF PIPE DIMENSIONS				LENGTH OF BARS				QUANTITIES	
Large in	Small in	Weight Pds	Feet	Area sq. in.	Weight Pds	Feet	Area sq. in.	Conc C.Y.	Steel Lbs
12	12	3.33	1.0	2.8	8.8	0.8	0.8	0.2	10
14	14	4.22	1.0	3.8	11.5	1.1	1.1	0.27	17
16	16	5.04	1.0	4.7	14.2	1.4	1.4	0.33	20
18	18	5.90	1.0	5.7	17.0	1.7	1.7	0.42	24
20	20	6.72	1.0	6.7	20.0	2.0	2.0	0.50	27
22	22	7.59	1.0	7.7	23.0	2.3	2.3	0.57	31
24	24	8.42	1.0	8.8	26.0	2.6	2.6	0.64	35
26	26	9.30	1.0	9.8	29.0	2.9	2.9	0.71	39
28	28	10.14	1.0	10.8	32.0	3.2	3.2	0.77	44
30	30	11.03	1.0	11.8	35.0	3.5	3.5	0.83	49
32	32	11.97	1.0	12.8	38.0	3.8	3.8	0.89	54
34	34	12.96	1.0	13.8	41.0	4.1	4.1	0.95	60
36	36	13.99	1.0	14.8	44.0	4.4	4.4	1.01	66
38	38	15.07	1.0	15.8	47.0	4.7	4.7	1.07	72
40	40	16.19	1.0	16.8	50.0	5.0	5.0	1.13	78
42	42	17.36	1.0	17.8	53.0	5.3	5.3	1.19	84
44	44	18.58	1.0	18.8	56.0	5.6	5.6	1.25	90
46	46	19.84	1.0	19.8	59.0	5.9	5.9	1.31	96
48	48	21.15	1.0	20.8	62.0	6.2	6.2	1.37	102
50	50	22.51	1.0	21.8	65.0	6.5	6.5	1.43	108
52	52	23.92	1.0	22.8	68.0	6.8	6.8	1.49	114
54	54	25.38	1.0	23.8	71.0	7.1	7.1	1.55	120
56	56	26.89	1.0	24.8	74.0	7.4	7.4	1.61	126
58	58	28.45	1.0	25.8	77.0	7.7	7.7	1.67	132
60	60	30.07	1.0	26.8	80.0	8.0	8.0	1.73	138
62	62	31.74	1.0	27.8	83.0	8.3	8.3	1.79	144
64	64	33.47	1.0	28.8	86.0	8.6	8.6	1.85	150
66	66	35.25	1.0	29.8	89.0	8.9	8.9	1.91	156
68	68	37.09	1.0	30.8	92.0	9.2	9.2	1.97	162
70	70	38.98	1.0	31.8	95.0	9.5	9.5	2.03	168
72	72	40.93	1.0	32.8	98.0	9.8	9.8	2.09	174
74	74	42.94	1.0	33.8	101.0	10.1	10.1	2.15	180
76	76	45.01	1.0	34.8	104.0	10.4	10.4	2.21	186
78	78	47.14	1.0	35.8	107.0	10.7	10.7	2.27	192
80	80	49.33	1.0	36.8	110.0	11.0	11.0	2.33	198
82	82	51.58	1.0	37.8	113.0	11.3	11.3	2.39	204
84	84	53.89	1.0	38.8	116.0	11.6	11.6	2.45	210
86	86	56.26	1.0	39.8	119.0	11.9	11.9	2.51	216
88	88	58.69	1.0	40.8	122.0	12.2	12.2	2.57	222
90	90							2.63	228

TABLE OF DIMENSIONS

TABLE OF DIMENSIONS

DIMENSIONS		QUANTITIES			
BOX	PIOE	Length	Width	Height	Weight
SIZE	SIZE	ft.	in.	ft.	lb.
A	B	C	D	E	F
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9
10	10	10	10	10	10
11	11	11	11	11	11
12	12	12	12	12	12
13	13	13	13	13	13
14	14	14	14	14	14
15	15	15	15	15	15
16	16	16	16	16	16
17	17	17	17	17	17
18	18	18	18	18	18
19	19	19	19	19	19
20	20	20	20	20	20
21	21	21	21	21	21
22	22	22	22	22	22
23	23	23	23	23	23
24	24	24	24	24	24
25	25	25	25	25	25
26	26	26	26	26	26
27	27	27	27	27	27
28	28	28	28	28	28
29	29	29	29	29	29
30	30	30	30	30	30



BENDING DIAGRAM FOR B-BARS

(For Type A and C Collar)



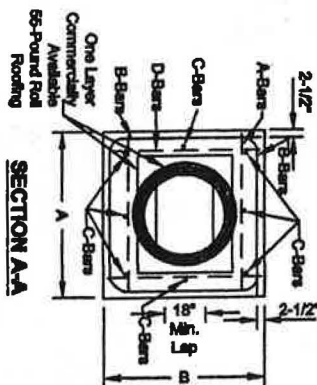
100

CITY OF PACIFIC, MISSOURI Standard Construction Details		
SEWER CONSTRUCTION DETAILS		
PIPE COLLARS		
Dr. T.R.L. Ch. R.L.B.	2000	SW.26

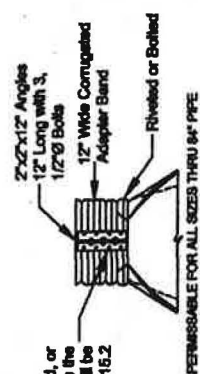
1. Do not scale drawing. F

1. Do not scale drawing. Follow dimensions.
2. Concrete used for collars shall be Class B.
3. Metal pipes for pipe collars shall be of the same gage and have the same configuration dimensions as the metal pipe to be connected.
4. If the pipe collar design is not applicable to the type of pipe being extended, the pipe collar shall be modified to insure a joint connection that will fit the pipe.

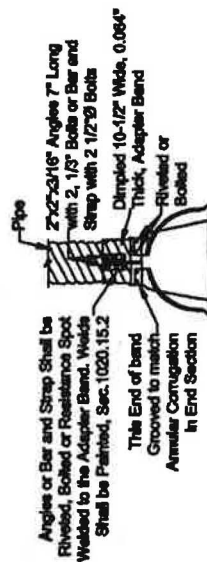
SECTION A-A



TYPE	ARCH DIMENSIONS APPROXIMATE	DIAL EQUIVALENT ROUNDED INCHES	END SECTIONS FOR ARCH PIPE					TOEPLATE IF SPICED IN INCHES
			THICK	W	H	L	W	
B5	100	100	.075	10	16	8	39	60
B6	120	120	.075	12	18	8	46	75
B7	140	140	.075	14	20	8	53	90
B8	160	160	.075	16	22	8	60	107
B9	180	180	.075	18	24	8	67	124
B10	200	200	.075	20	26	8	74	141
B11	220	220	.075	22	28	8	81	158
B12	240	240	.075	24	30	8	88	175
B13	260	260	.075	26	32	8	95	192
B14	280	280	.075	28	34	8	102	209
B15	300	300	.075	30	36	8	109	226
B16	320	320	.075	32	38	8	116	243
B17	340	340	.075	34	40	8	123	260
B18	360	360	.075	36	42	8	130	277
B19	380	380	.075	38	44	8	137	294
B20	400	400	.075	40	46	8	144	311
B21	420	420	.075	42	48	8	151	328
B22	440	440	.075	44	50	8	158	345
B23	460	460	.075	46	52	8	165	362
B24	480	480	.075	48	54	8	172	379
B25	500	500	.075	50	56	8	179	396
B26	520	520	.075	52	58	8	186	413
B27	540	540	.075	54	60	8	193	430
B28	560	560	.075	56	62	8	200	447
B29	580	580	.075	58	64	8	207	464
B30	600	600	.075	60	66	8	214	481
B31	620	620	.075	62	68	8	221	498
B32	640	640	.075	64	70	8	228	515
B33	660	660	.075	66	72	8	235	532
B34	680	680	.075	68	74	8	242	549
B35	700	700	.075	70	76	8	249	566
B36	720	720	.075	72	78	8	256	583
B37	740	740	.075	74	80	8	263	600
B38	760	760	.075	76	82	8	270	617
B39	780	780	.075	78	84	8	277	634
B40	800	800	.075	80	86	8	284	651
B41	820	820	.075	82	88	8	291	668
B42	840	840	.075	84	90	8	298	685
B43	860	860	.075	86	92	8	305	702
B44	880	880	.075	88	94	8	312	719
B45	900	900	.075	90	96	8	319	736
B46	920	920	.075	92	98	8	326	753
B47	940	940	.075	94	100	8	333	770
B48	960	960	.075	96	102	8	340	787
B49	980	980	.075	98	104	8	347	804
B50	1000	1000	.075	100	106	8	354	821



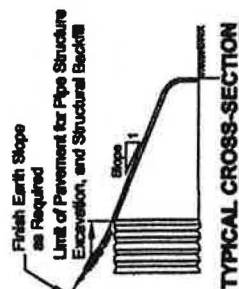
PERMISSIBLE FOR ALL SIZES THRU 84" PIPE
AND 8-12 OR 8-12A PIPE ARCH
TYPE 5 CONNECTION



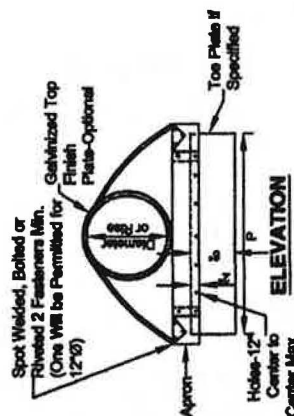
FOR 12" THRU 42" PIPE AND EQUIVALENT PIPE ARCH
TYPE 4 CONNECTION



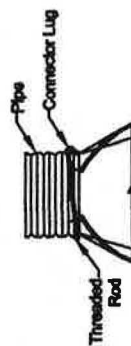
CONNECTOR STRAP



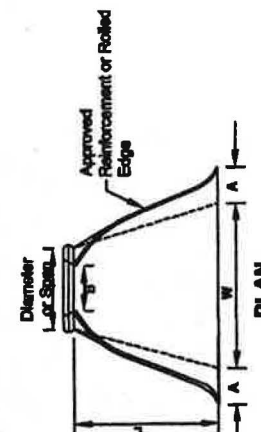
TYPICAL CROSS-SECTION



FOR 30" THRU 48" PIPE AND EQUIVALENT PIPE ARCH
TYPE 2 CONNECTION



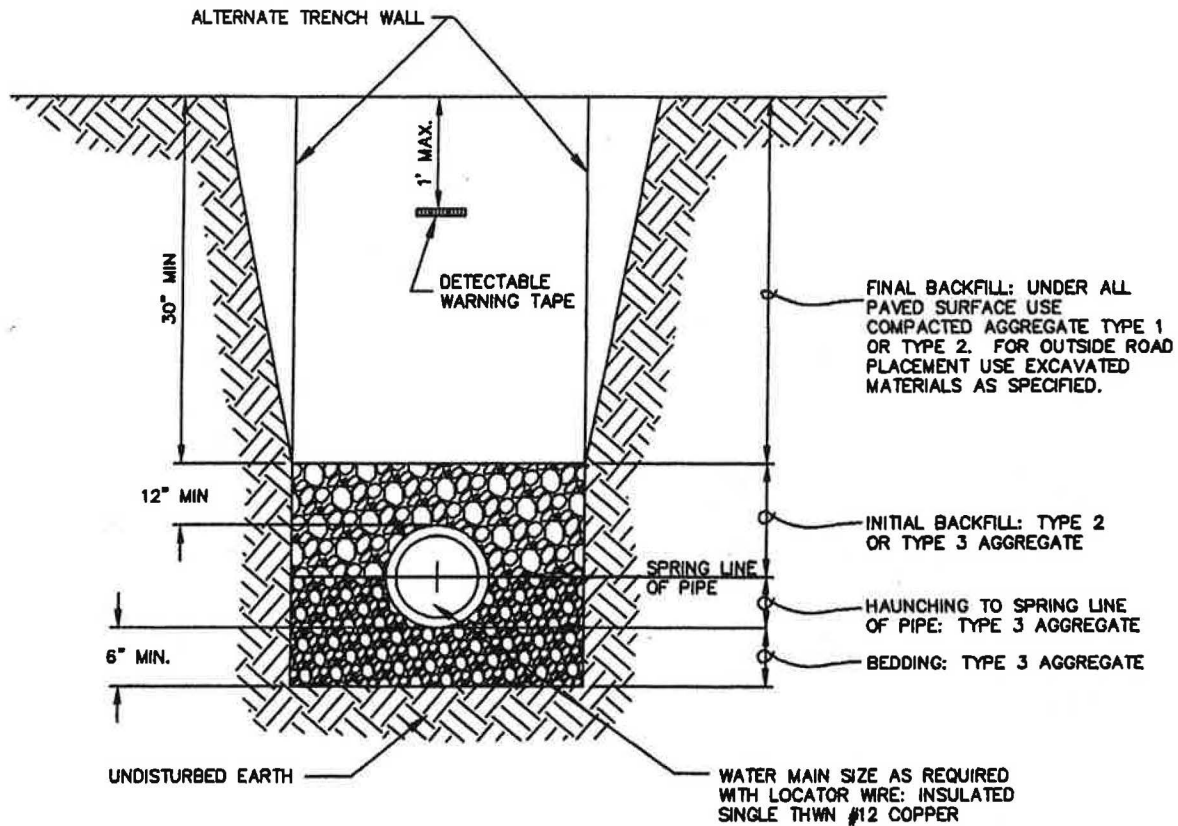
FOR 12" THRU 24" ROUND PIPE ONLY
TYPE 1 CONNECTION



END SECTION FOR PIPE AND PIPE ARCH

- GENERAL NOTES:**
- 1) Minor variations of details and dimensions indicated will be accepted to permit the use of a manufacturer's standard methods of fabrication.
 - 2) End Sections fabricated from thicker metal than indicated will be accepted.
 - 3) All bolts shall be 3/8 inch diameter and galvanized, unless otherwise shown.
 - 4) Toeplates, if specified, shall be punched to match holes in the apron.
 - 5) Skirt Section is defined as the flared portion of the End Section including side and bottom (center) panels and apron.
 - 6) Skirt Sections for 12 inch thru 24 inch pipes shall be made in one piece.
 - 7) Skirt Section for 30 inch and larger pipes 85 and larger pipe arches may be made from up to 2 sheets joined by riveting or bolting on centerline.
 - 8) Skirt Sections for 48 inch and larger pipes and 88 and larger pipe arches may be made from up to 3 sheets joined by riveting or bolting equal distance from centerline.
 - 9) Skirt Section for 72 inch and larger pipes may be made from up to 4 sheets joined by riveting or bolting. The bottom panel shall be 2 equal width sheets joined on centerline.
 - 10) All 3 piece and 4 piece skirts for 60 inch or larger pipes and 810 and larger pipe arches shall have 0.108 inch thick sides and 0.138 inch thick bottom (center) panels. Width of bottom panels shall be greater than 20% of the pipe periphery connector sections. Corner plates and toeplates shall be galvanized and of the same or greater thickness as the skirt.

CITY OF PACIFIC, MISSOURI Standard Construction Details	
FLARED END SECTION (METAL)	
Dr. T.R.L. 2000	SW.27
Ch. R.L.B.	



PIPE TRENCHING & BEDDING DETAIL

NO SCALE

NOTES:

1. DETECTABLE WARNING TAPE AS MANUFACTURED BY SAFETY PRODUCTS, OR EQUAL. TAPE SHALL BE 3-INCH WIDE, CODED COLOR BLUE, AND HAVE TEXT DENOTING "CAUTION: BURIED WATER LINE BELOW".
2. AGGREGATE MATERIALS SHALL BE TYPE 1, TYPE 2 OR TYPE 3.
3. AGGREGATE PLACED UNDER ROADWAYS SHALL BE COMPACTED DURING EACH 6-INCH LIFT PLACEMENT.

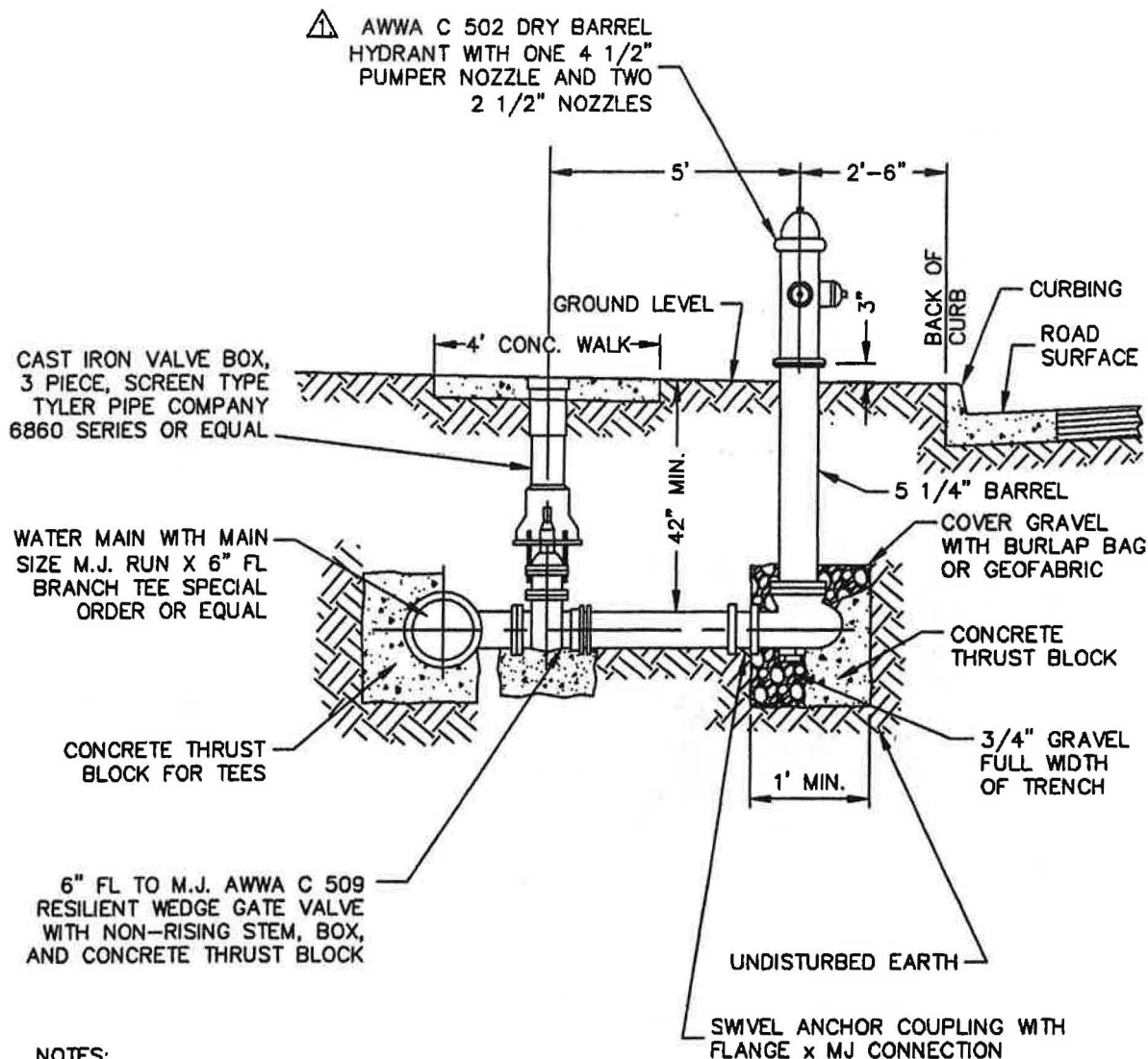
WATER MAIN BACKFILL MATERIAL

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. G.T.
Ch. R.L.B.

2000

WS.01



NOTES:

1. HYDRANTS TO BE ONE OF THE FOLLOWING:
 MUELLER SUPER CENTURION 250, MODEL A-423
 KENNEDY GUARDIAN, MODEL K81D OR
 AMERICAN FLOW CONTROL AMERICAN-DARLING, MODEL B-84-B
2. THE GRAVEL FILLED AREA SHOULD CONTAIN A VOLUME OF WATER AT LEAST TWICE THAT HELD BY THE HYDRANT BARREL.

FIRE-HYDRANT SETTING
BACK OF CURB

NO SCALE

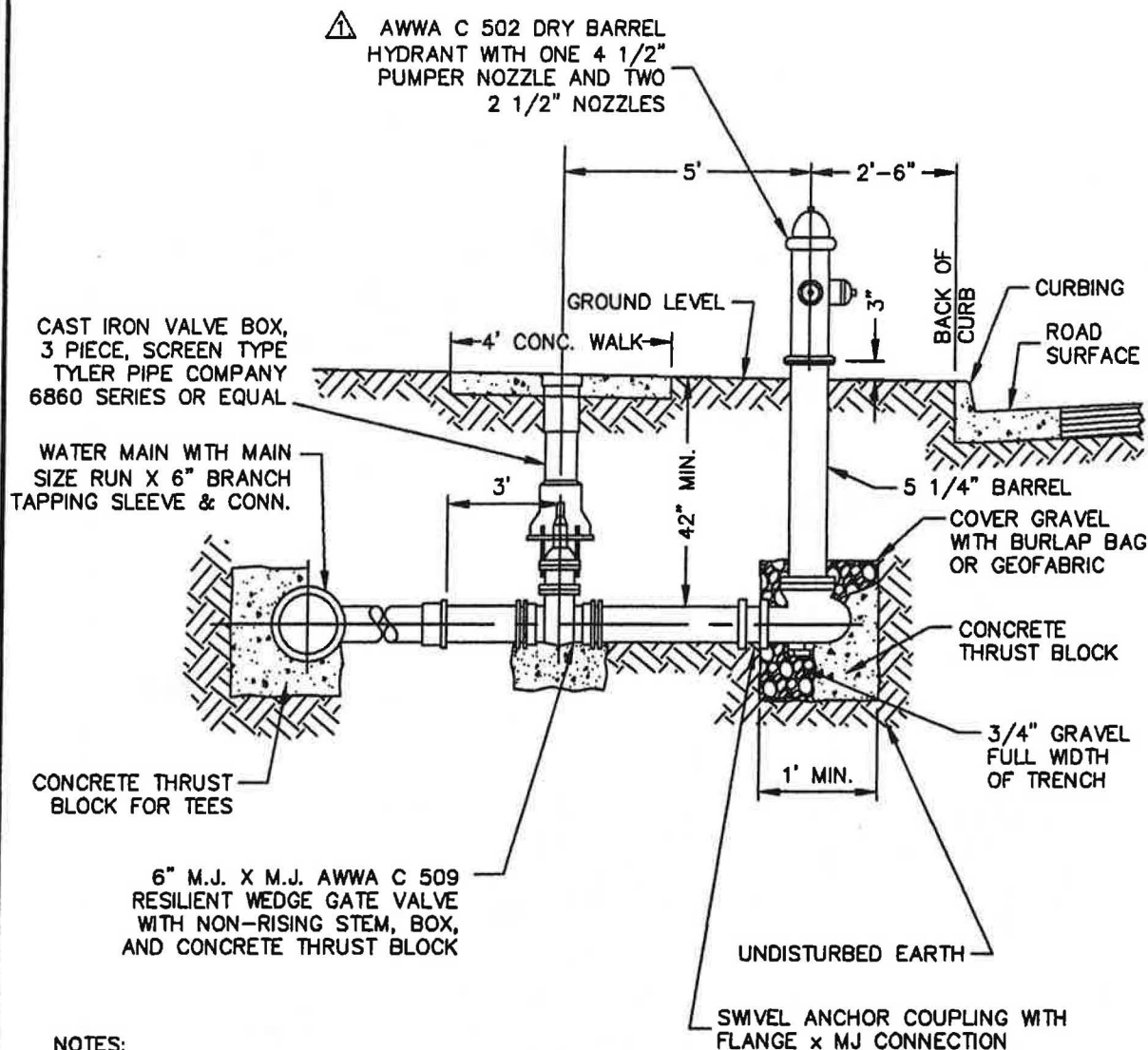
FIRE-HYDRANT SETTING
BACK OF CURB
 CONNECTION TO NEW WATER MAIN

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. G.T.
Ch. R.L.B.

2000

WS.02
Sh 1



NOTES:

1. HYDRANTS TO BE ONE OF THE FOLLOWING:
 MUELLER SUPER CENTURION 250, MODEL A-423
 KENNEDY GUARDIAN, MODEL K81D OR
 AMERICAN FLOW CONTROL AMERICAN-DARLING, MODEL B-84-B
2. THE GRAVEL FILLED AREA SHOULD CONTAIN A VOLUME OF WATER
 AT LEAST TWICE THAT HELD BY THE HYDRANT BARREL.

FIRE-HYDRANT SETTING
BACK OF CURB

NO SCALE

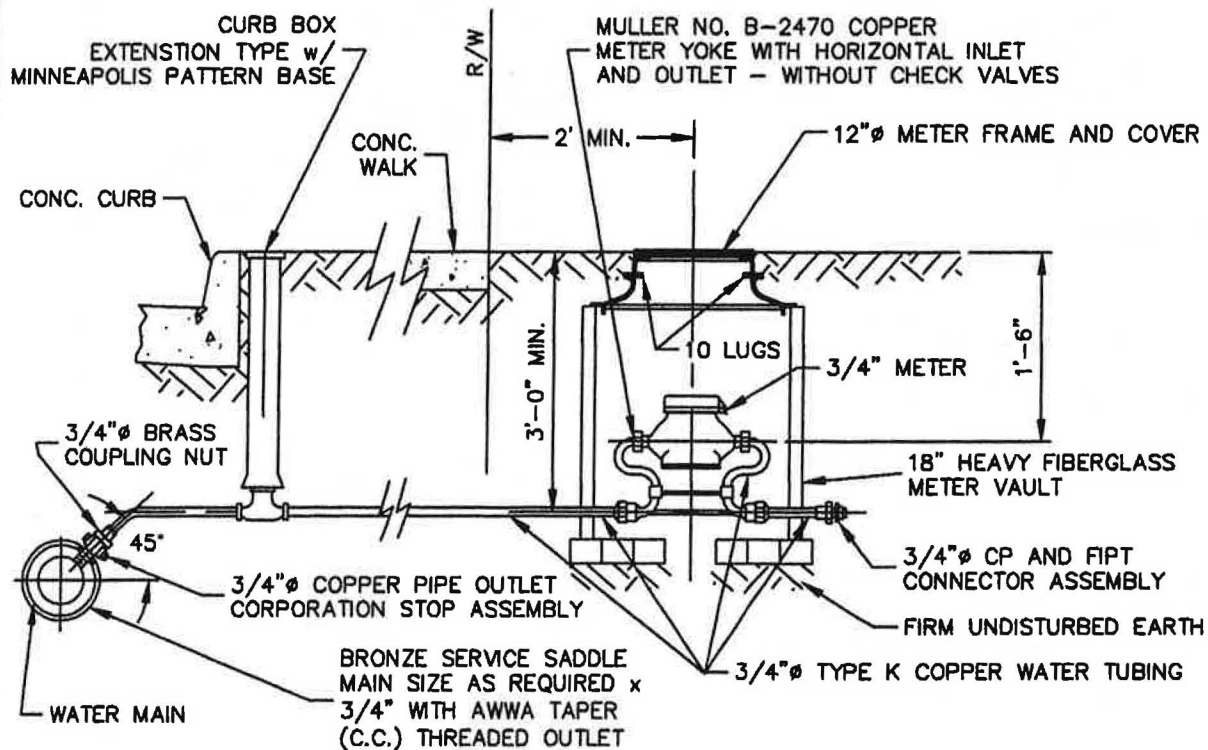
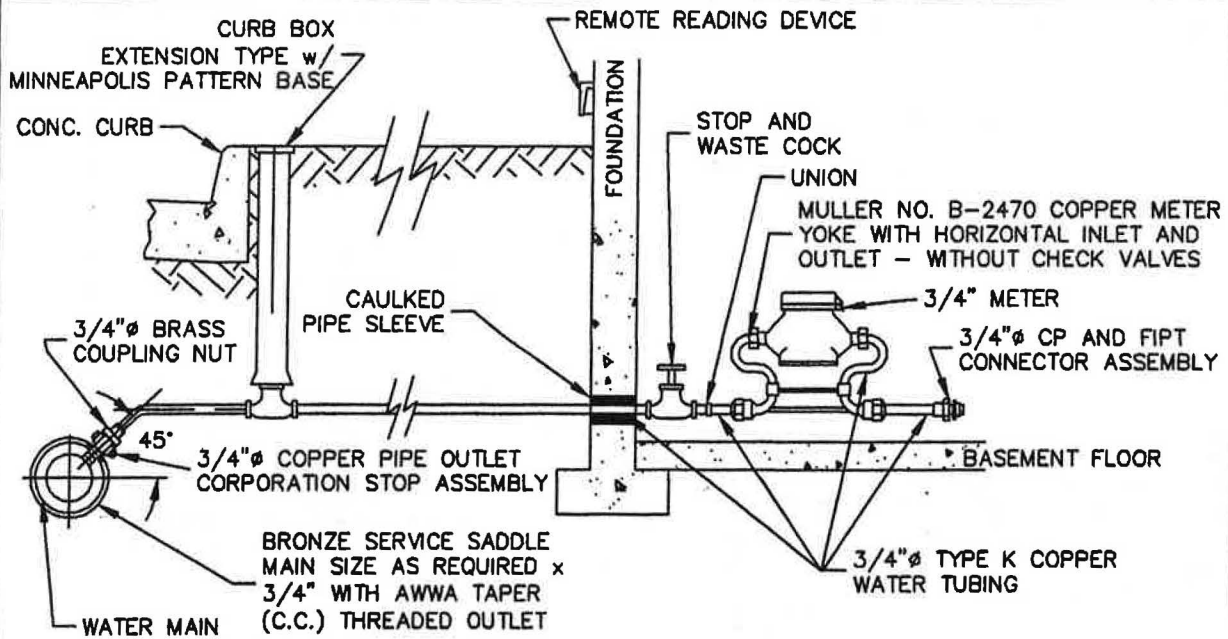
FIRE-HYDRANT SETTING
BACK OF CURB
 CONNECTION TO EXISTING WATER MAIN

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. G.T.
Ch. R.L.B.

2000

WS.02
Sh 2



TYPICAL INSTALLATION OF 3/4" METERED DOMESTIC SERVICE

NO SCALE

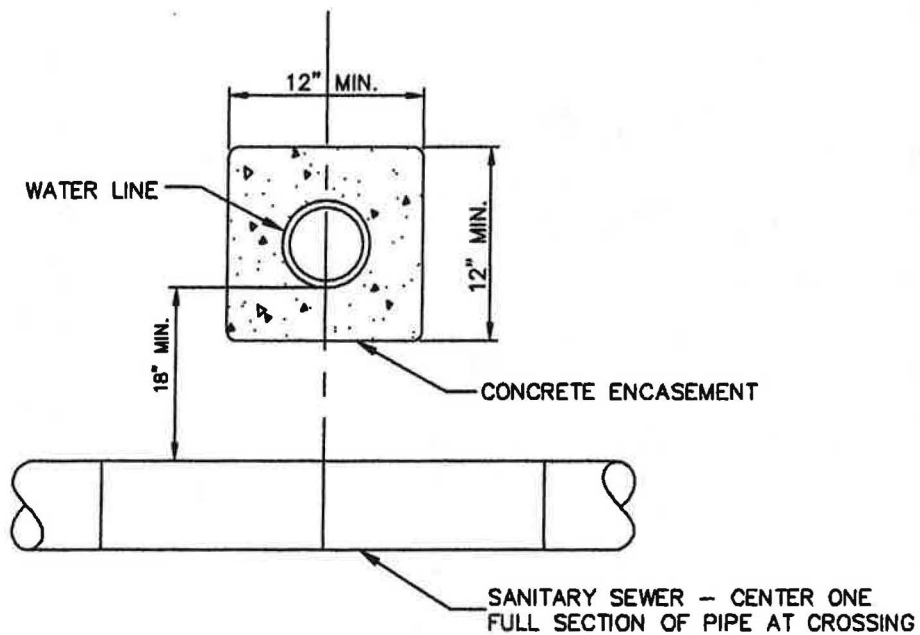
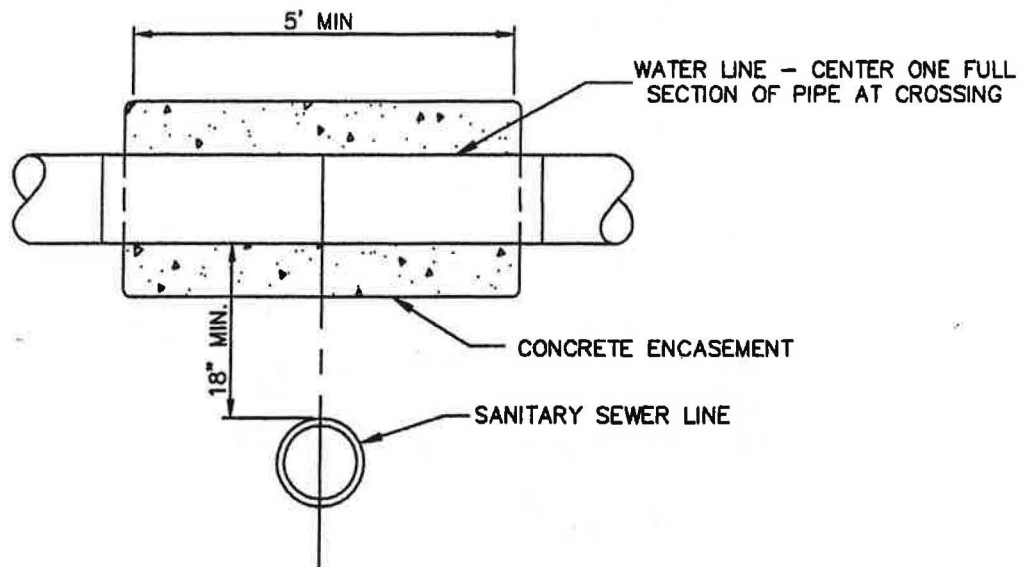
**TYPICAL INSTALLATION OF 3/4"
METERED DOMESTIC SERVICE**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. P.D.H.
Ch. R.L.B.

2000

WS.03



TYPICAL PIPE CROSSING DETAILS

NO SCALE

**WATER & SEWER MAINS
CROSSING DETAIL**

CITY OF PACIFIC, MISSOURI
Standard Construction Details

Dr. J.R.E.
Ch. R.L.B.

2000

WS.04

Thrust For Various Fittings And Test Pressures Thrust In Pounds

PipeSize	90° Bend			Tees & Terminal Ends			45° Bend			22 1/2° Bend			11 1/4° Bend		
	300 Test Pr	150 Test Pr	100 Test Pr	300 Test Pr	150 Test Pr	100 Test Pr	300 Test Pr	150 Test Pr	100 Test Pr	300 Test Pr	150 Test Pr	100 Test Pr	300 Test Pr	150 Test Pr	100 Test Pr
2 inch	1400	700	500	1000	500	—	800	400	—	400	—	—	—	—	—
4 inch	6000	3000	2000	4000	2000	1000	3000	1500	1000	1600	800	500	800	400	—
6 inch	12000	6000	4000	8000	4000	3000	8000	4000	2000	4000	2000	1000	2000	1000	600
8 inch	22000	11000	7000	16000	8000	5000	12000	6000	4000	6000	3000	2000	4000	2000	1000
10 inch	34000	17000	11000	24000	12000	8000	20000	10000	6000	10000	5000	3000	6000	3000	2000
12 inch	48000	24000	16000	34000	17000	11000	28000	14000	9000	14000	7000	5000	8000	4000	2000
14 inch	66000	33000	22000	46000	23000	15000	38000	19000	13000	18000	9000	6000	10000	5000	3000
16 inch	86000	43000	19000	60000	30000	20000	50000	25000	16000	24000	12000	8000	12000	6000	4000
18 inch	108000	54000	37000	76000	38000	25000	64000	32000	20000	30000	15000	10000	16000	8000	5000

Note: For area of thrust block in square feet, divide appropriate thrust by allowable soil bearing.
Test pressures shall be as indicated in the specifications or special conditions under pressure testing of pipe. The design engineer shall be responsible for selecting thrust blocks or anchorage for various pipe size and fittings according to appropriate soil bearing and test pressure. Cost of thrust anchorage shall be included in price bid for fittings or pipe.

Allowable Safe Lateral Bearing Of Soils In Pounds Per Square Foot

Muck and Peat	0*
Soft Clay	500
Sand	100
Sand and Gravel	1500
Sand and Gravel cementec w/Clay	2000
Shale	5000

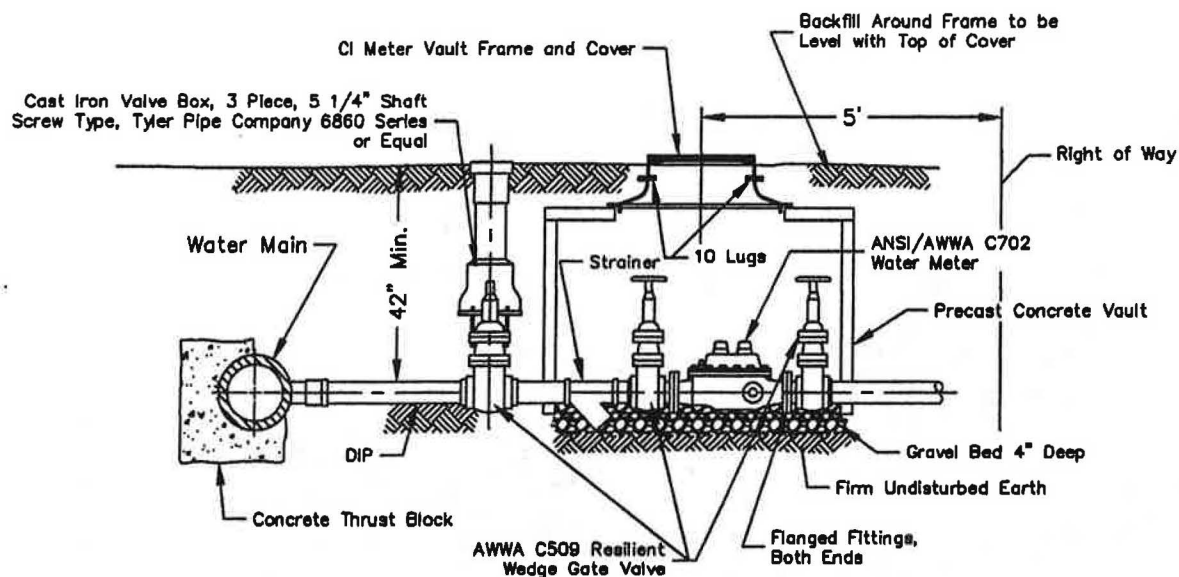
Notes: Soils Engineer to provide soil bearing pressure allowable. (*Use tie-rod anchors, locking joint fittings, or treated timber piles w/concrete thrust blocks)

DATA FOR THRUST BLOCKING AND ANCHORAGE

CITY OF PACIFIC, MISSOURI
Standard Construction Details

THRUST ANCHORAGE CRITERIA

Dr. T.R.L. Ch. R.L.B.	2000	WS.05
--------------------------	------	-------



Notes:

1. Area to be computed based on bearing strength of soil and thrust anchorage criteria, see "Thrust Anchorage Data" on this sheet.
2. Valve to be Mueller A-2360, Kennedy Ken-Seal II, or American Flow Control 2500.
3. DIP to be cement mortar lined with mechanical joints conforming to ANSI/AWWA C151 and ANSI/AWWA C104.
4. Thickness of DIP to be determined in accordance with ANSI/AWWA C150, but in no case will thickness less than Class 51 be used.
5. All fittings to be DI conforming to ANSI/AWWA C110 or ANSI/AWWA C153. Fittings to be cement mortar lined per ANSI/AWWA C104.
6. Meter to conform to ANSI/AWWA C702 "AWWA Standard for Cold-Water Meters - Compound Type". Meter to be Neptune Tru/Flo as manufactured by Schlumberger Industries. See Note 7.
7. Meter to be purchased from the City of Pacific, Missouri.
8. Meter vault lid and frame to be cast iron lid and frame as manufactured by the Mueller Co. or the Ford Meter Box Co.. Frame to be of single lid type with a minimum depth of 4". Lid to be flat with side mounted standard waterworks pentagon nut lock.

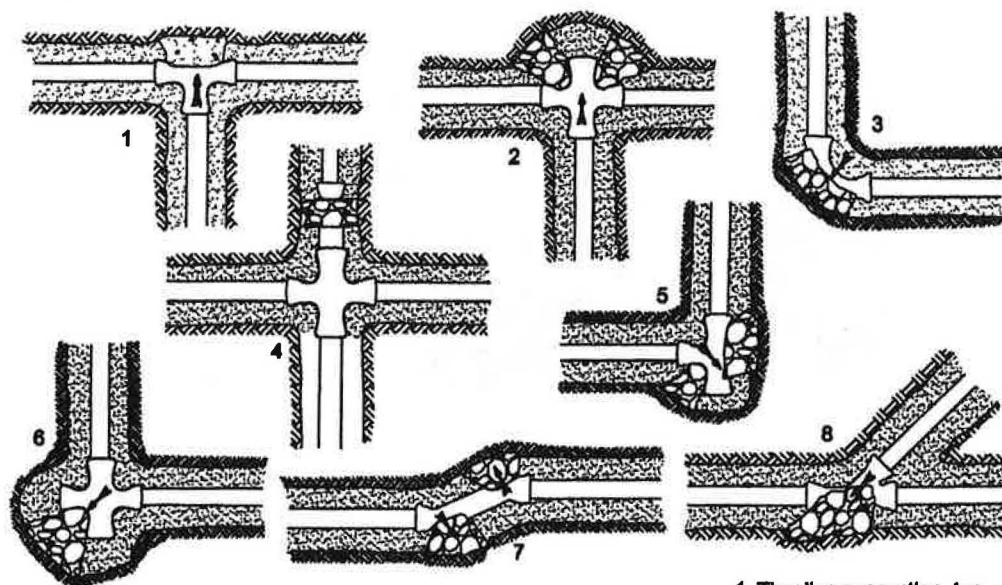
INDUSTRIAL SERVICE CONNECTION
METER IN VAULT
2" THROUGH 6" DIAMETER

CITY OF PACIFIC, MISSOURI
Standard Construction Details

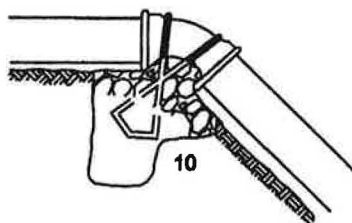
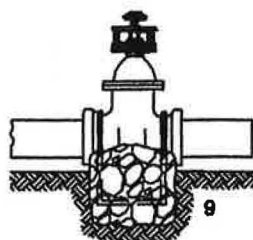
Dr. T.R.L.
Ch. R.L.B.

2000

WS.06



If thrusts, due to high pressure, are expected, anchor valves as below. At vertical bends, anchor to resist outward thrusts.



1. Thru line connection, tee
2. Thru line connection, cross used as tee.
3. Direction change, elbow
4. Change line size, reducer
5. Direction change, tee used as elbow
6. Direction change, cross used as elbow
7. Direction change
8. Thru line connection, wye
9. Valve anchor
10. Direction change vertical, bend anchor

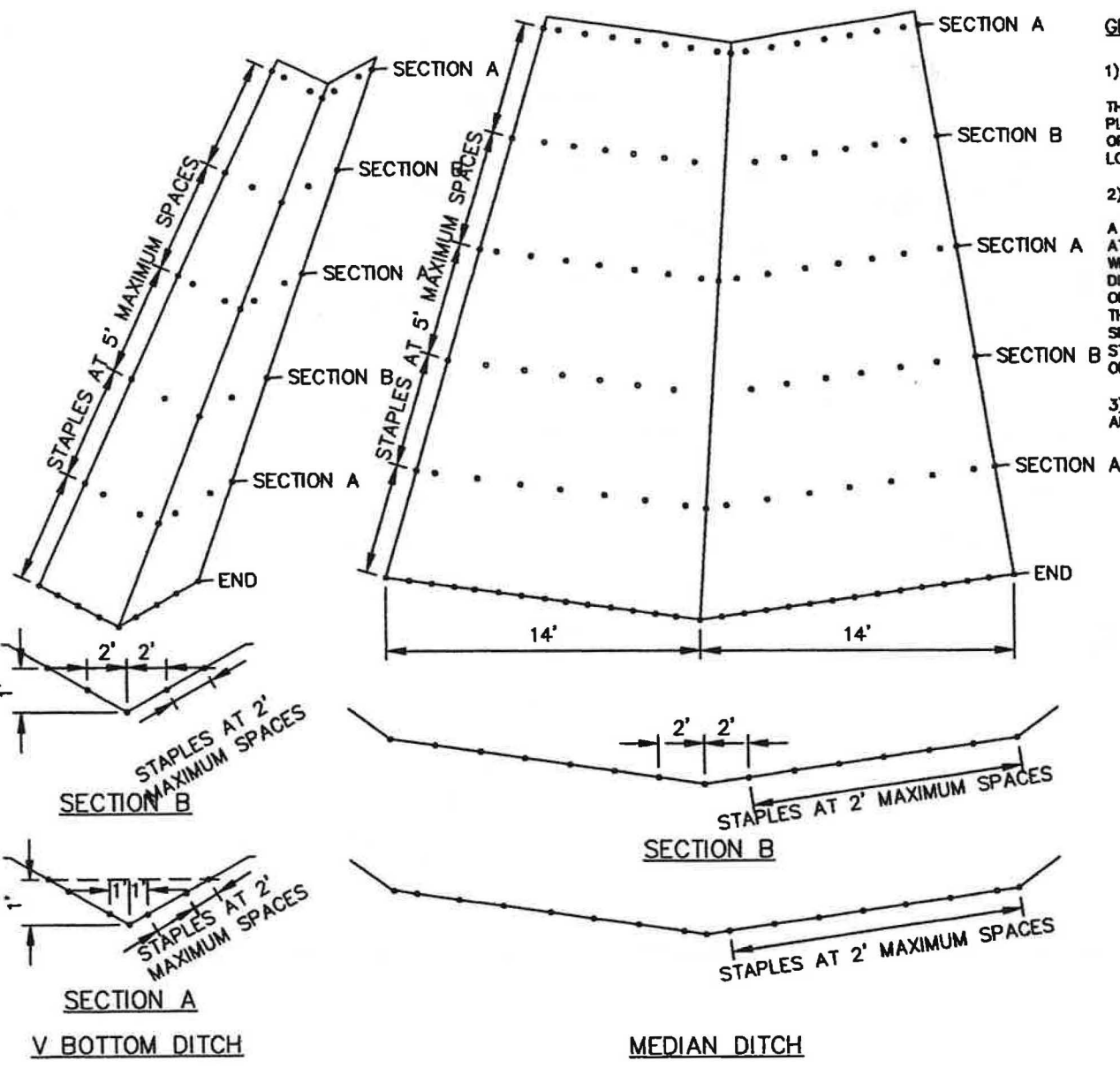
TYPES OF THRUST BLOCKS

CITY OF PACIFIC, MISSOURI Standard Construction Details

Dr. T.R.L.
Ch. R.L.B.

2000

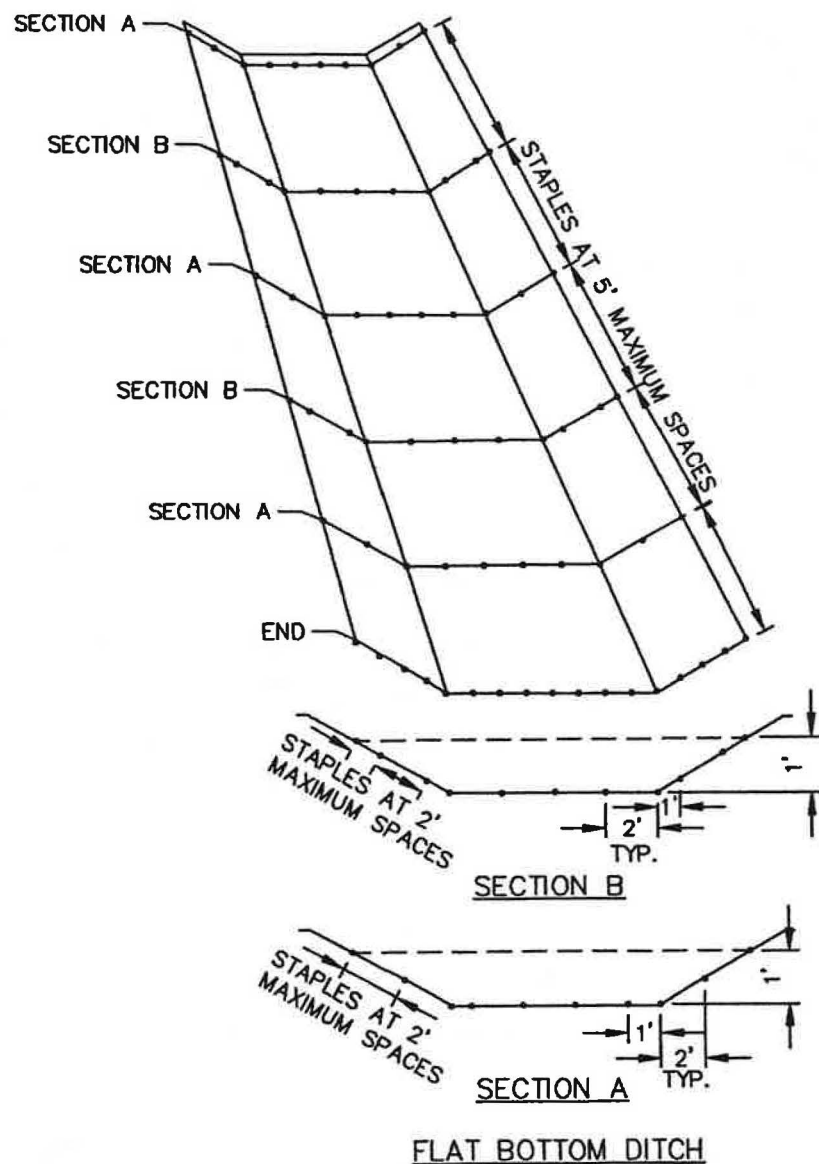
WS.07



GENERAL NOTES

- 1) STAPLES AT JOINTS AND ENDS.
THE NETTING SHALL BE SECURED WITH STAPLES PLACED ON ONE FOOT CENTERS AT BOTH ENDS OF THE NETTING, AND AT ALL TRANSVERSE AND LONGITUDINAL JOINTS.
- 2) TRANSVERSE STAPLE LINES.
A LINE OF TRANSVERSE STAPLES WILL BE PLACED AT FIVE FOOT LONGITUDINAL INCREMENTS. A STAPLE WILL BE PLACES AT ALL SLOPE CHANGES IN THE DITCH CROSS SECTION AND AT THE OUTER EDGES OF THE NETTING. INTERMEDIATE STAPLES BETWEEN THE OUTER EDGES AND BETWEEN THE SLOPE CHANGES SHALL BE PLACED AT MAXIMUM TWO FOOT SPACING, STAGGERED TO PREVENT STRAIGHT LONGITUDINAL LINES OF STAPLES.
- 3) STAPLES AT ONE FOOT MAXIMUM SPACES ON ENDS AND JOINTS.

CITY OF PACIFIC, MISSOURI Standard Construction Details		
STAPLE PLACEMENT FOR PLASTIC NETTING		
Dr. T.R.L. Ch. R.L.B.	2000	MD.06 Sh 1



GENERAL NOTES

1) STAPLES AT JOINTS AND ENDS.

THE NETTING SHALL BE SECURED WITH STAPLES AT BOTH ENDS OF THE NETTING, AND AT ALL TRANSVERSE AND LONGITUDINAL JOINTS.

2) TRANSVERSE STAPLE LINES

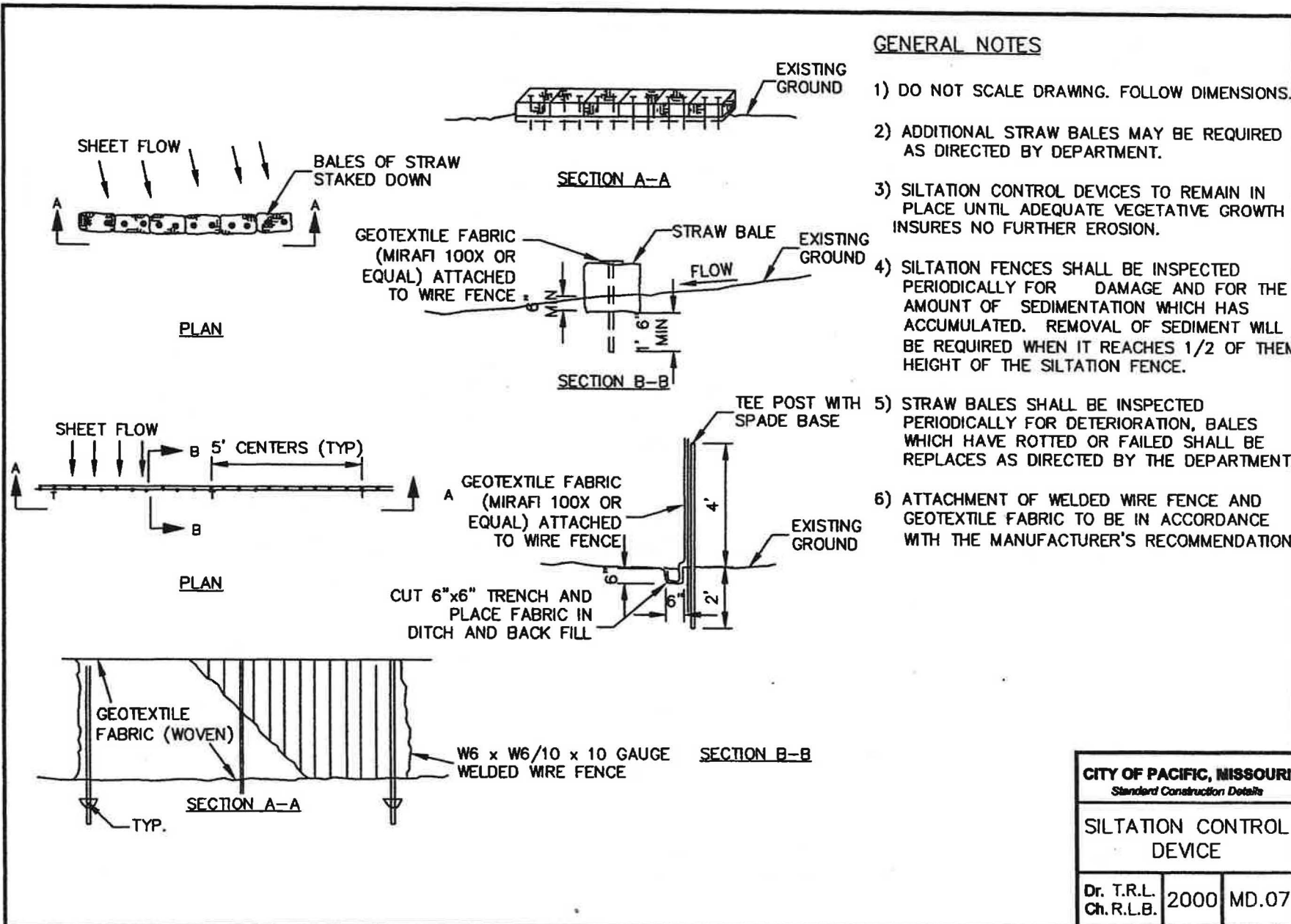
A LINE OF TRANSVERSE STAPLES WILL BE PLACES AT FIVE FOOT LONGITUDINAL INCREMENTS. A STAPLE WILL BE PLACES AT ALL SLOPE CHANGES IN THE DITCH CROSS SECTION AND AT THE OUTER EDGES OF THE NETTING. INTERMEDIATE STAPLES BETWEEN THE OUTER EDGES AND BETWEEN SLOPE CHANGES SHALL BE PLACED A MAXIMUM TWO FOOT SPACES, STAGGERED TO PREVENT STRAIGHT LONGITUDINAL LINES OF STAPLES.

3) STAPLES AT ONE FOOT MAXIMUM SPACES ON ENDS AND JOINTS.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

**STAPLE PLACEMENT
FOR PLASTIC NETTING**

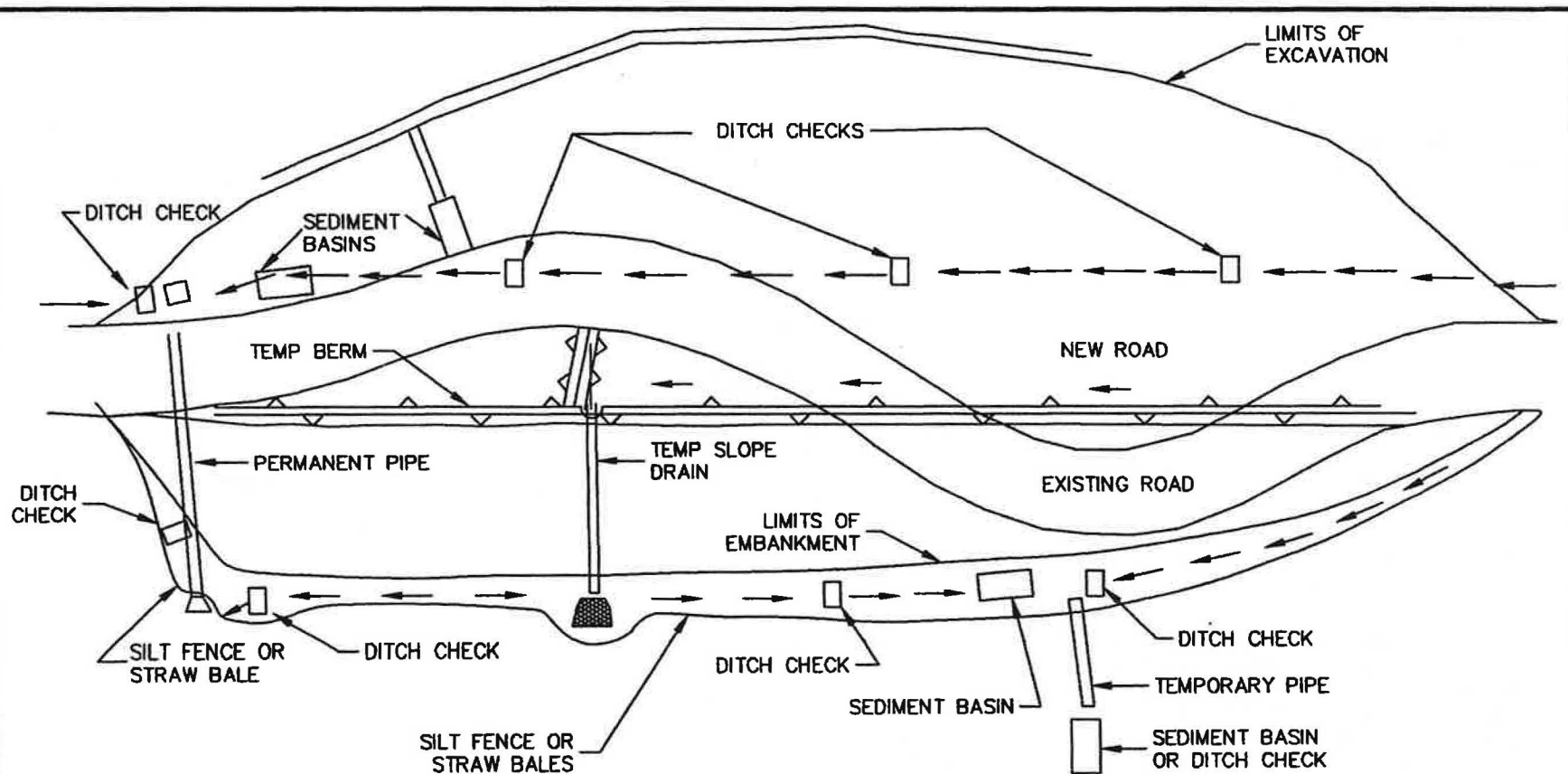
Dr. T.R.L. Ch. R.L.B.	2000	MD.06 2
--------------------------	------	------------



CITY OF PACIFIC, MISSOURI
Standard Construction Details

**SILTATION CONTROL
DEVICE**

Dr. T.R.L. Ch. R.L.B.	2000	MD.07
--------------------------	------	-------



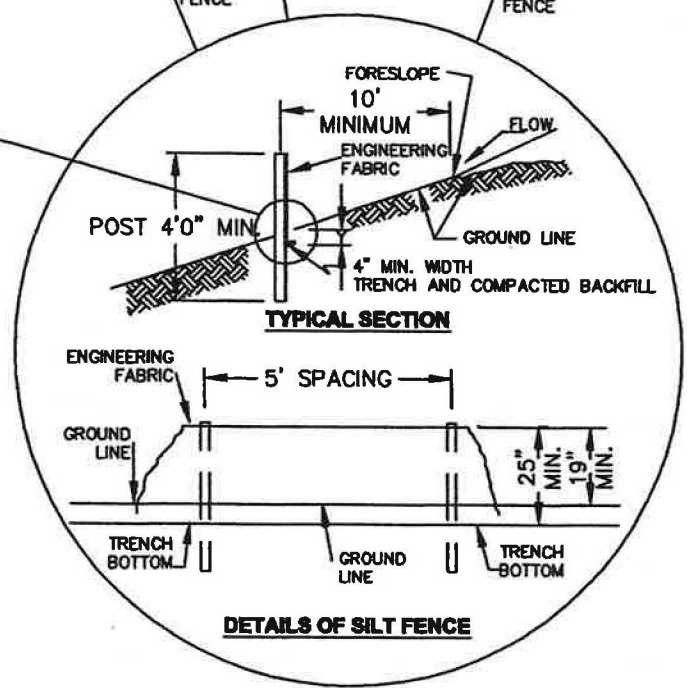
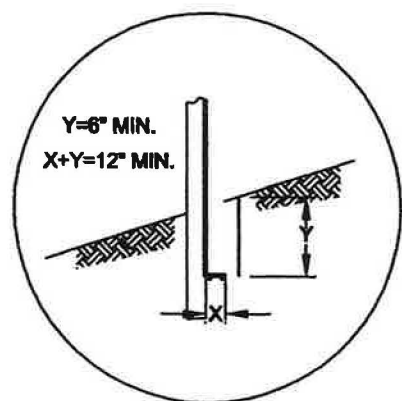
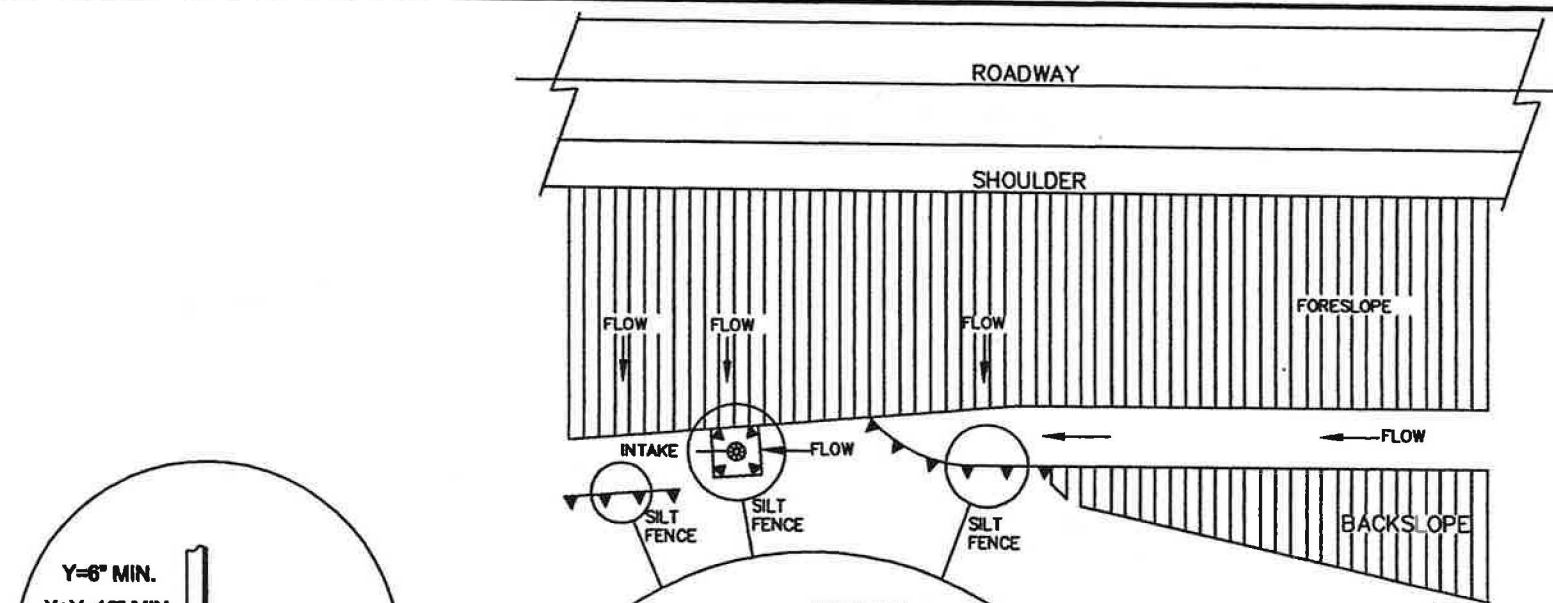
NOTES:

- 1) EROSION CONTROL MEASURES ARE SHOWN HERE AS GENERAL EXAMPLES. ACTUAL CONDITIONS MAY DICTATE MORE OR FEWER MEASURES.
- 2) C=CUT LIMITS; F=FILL LIMITS.
- 3) TEMPORARY OR FINAL SEEDING IMMEDIATELY UPON COMPLETION OF GRADING.
- 4) WOOD POSTS SHALL BE USED FOR ALL STRAW BALE APPLICATIONS.
- 5) STRAW BALES USED AS SILT FENCE SHALL BE IMBEDDED 6 INCHES.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

**TEMPORARY EROSION
CONTROL MEASURES**

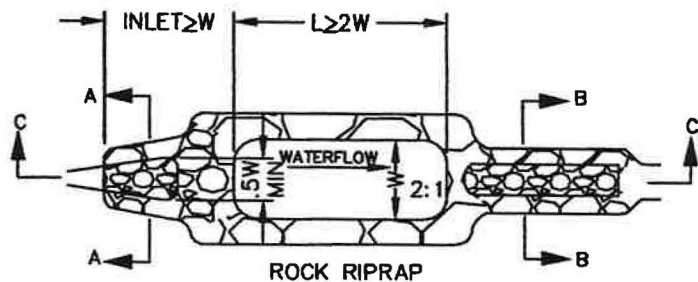
Dr. T.R.L. Ch.R.L.B.	2000	MD.08 Sh 1
-------------------------	------	---------------



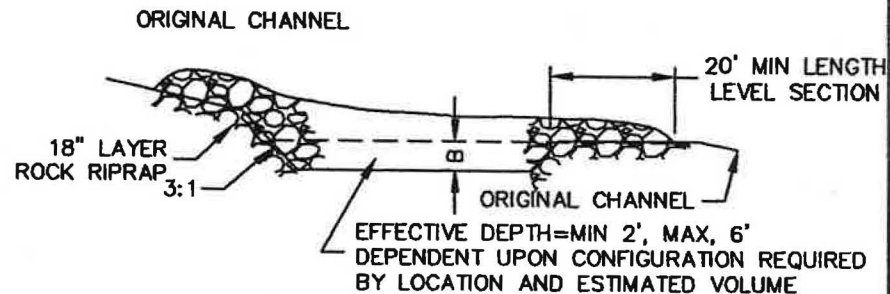
GENERAL NOTES:

1. MINIMUM LONGITUDINAL SPICE OVERLAP SHALL BE 2' WITH A POST AT EACH END.
2. SECURE FABRIC TO POSTS.
3. SUPPORT FENCE REQUIRED WITH SILT FENCE AROUND DROP INLET OR WHEN USED ACROSS DITCH.

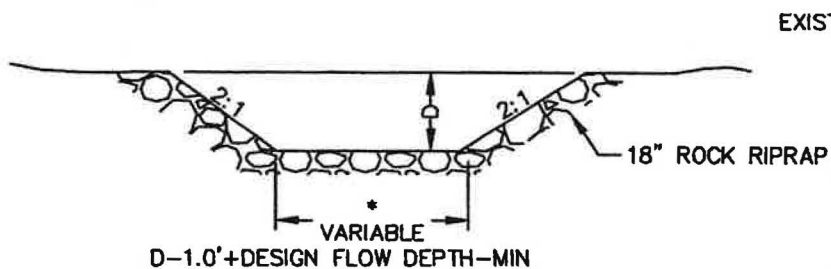
CITY OF PACIFIC, MISSOURI		
Standard Construction Details		
TEMPORARY EROSION CONTROL MEASURES		
SILT FENCE		
Dr. T.R.L. Ch. R.L.B.	2000	MD.08 Sh 2



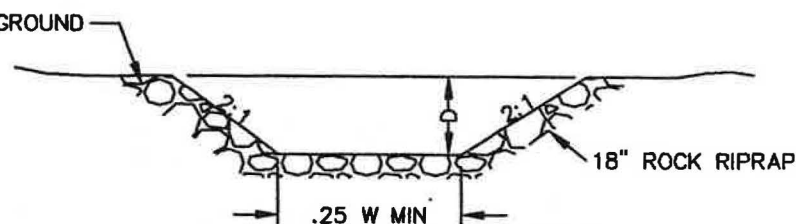
PLAN VIEW



SECTION C-C



SECTION A-A
INLET

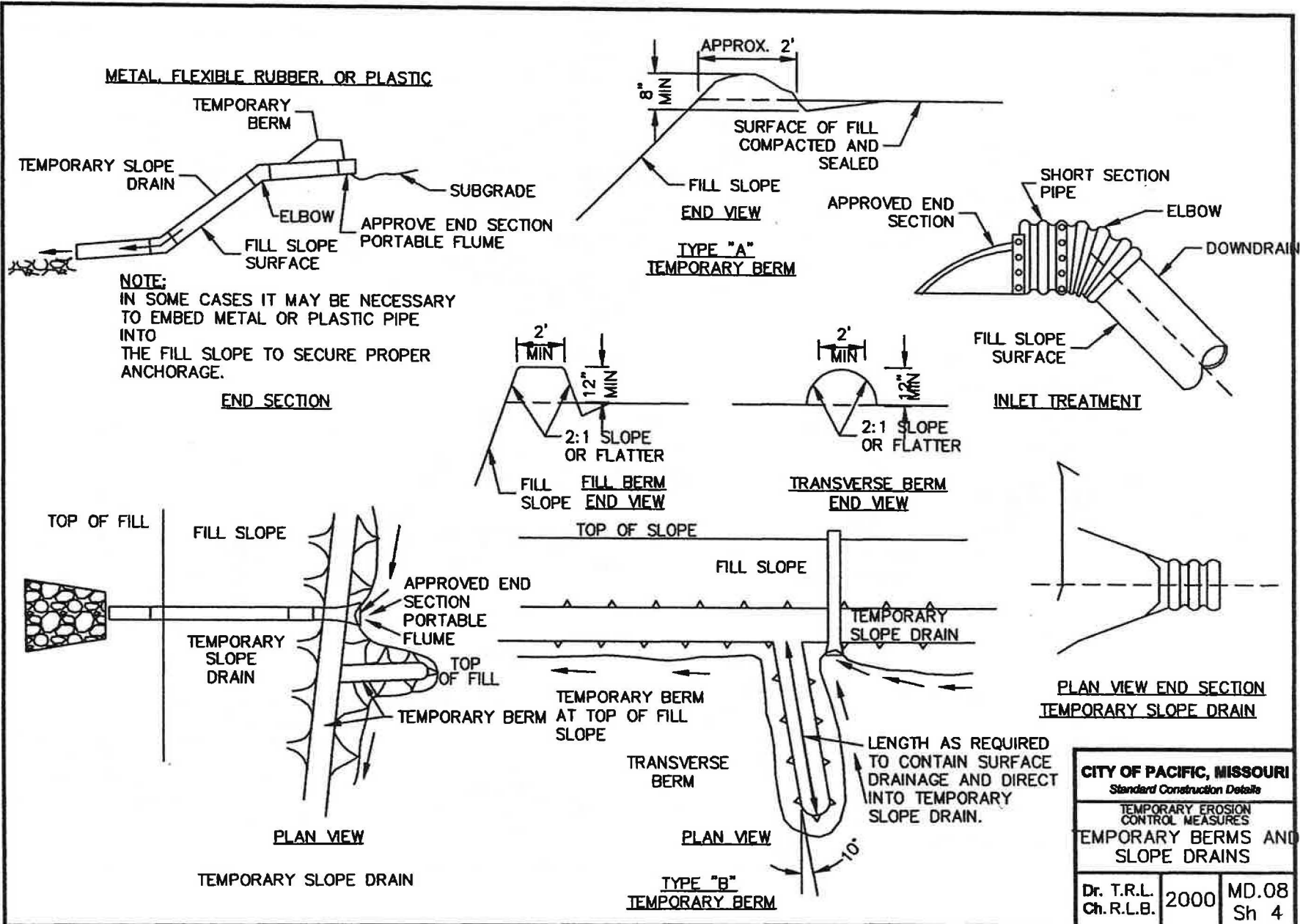


SECTION B-B
OUTLET

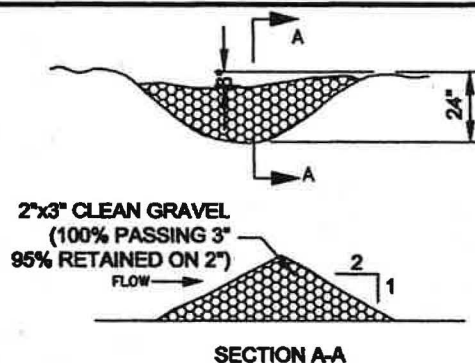
GENERAL NOTES:

- 1) THE MATERIALS FOR ROCK RIPRAP SHALL MEET THE REQUIREMENTS OF SEC.611.30 FOR TYPE 2 ROCK BLANKET.
- 2) SEE PLANS FOR LENGTH, DEPTH, AND WIDTH OF BASIN
- 3) SEE PLANS FOR ESTIMATED QUANTITIES OF ROCK RIPRAP—CUBIC YARDS.

CITY OF PACIFIC, MISSOURI		
<i>Standard Construction Details</i>		
TEMPORARY EROSION CONTROL MEASURES		
SEDIMENT BASIN		
Dr. T.R.L. Ch.R.L.B.	2000	MD.08 Sh 3



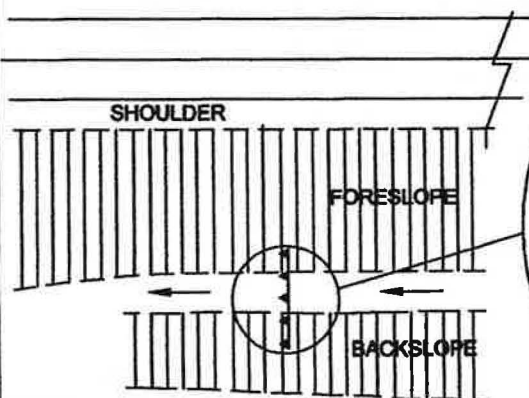
ALL TYPES DITCH CHECK SPACING	
DITCH & SLOPE %	SPACING (FT.)
.05	400
1.0	200
1.5	133
2.0	100
2.5	80
3.0	66
3.5	57
4.0	50
4.5	44
5.0	40
5.5	38
6.0	35
6.5	30
7.0	28
7.5	26
8.0	25
8.5	23
9.0	22
9.5	21
10.0	20



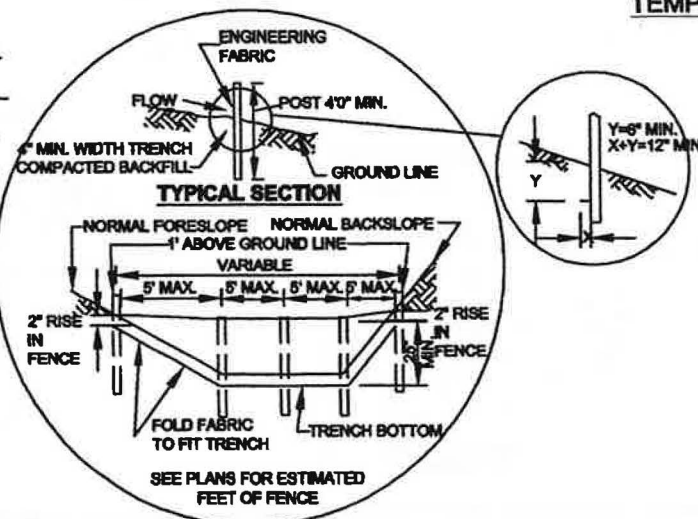
NOTE:
THE DITCH CHECK SHALL BE REMOVED WHEN THE GRASS HAS MATURED SUFFICIENTLY TO PROTECT THE DITCH, SWALE, OR THE CONCRETE DITCH LINER HAS BEEN CONSTRUCTED.

THE AREA BENEATH THE ROCK DITCH CHECK SHALL BE SEEDED AND MULCHED OR CONSTRUCTED IN CONCRETE IMMEDIATELY AFTER THEY ARE REMOVED. DO NOT USE ON GRADES STEEPER THAN 4%.

TEMPORARY ROCK DITCH CHECK



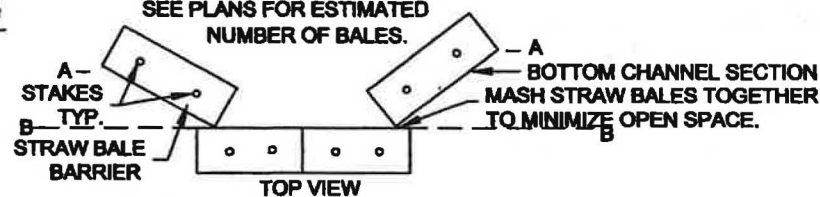
- NOTE:**
1. SUPPORT FENCE REQUIRED WITH SILT FENCE DITCH CHECK.
 2. POST SHALL BE STEEL T-POST OR EQUIVALENT.



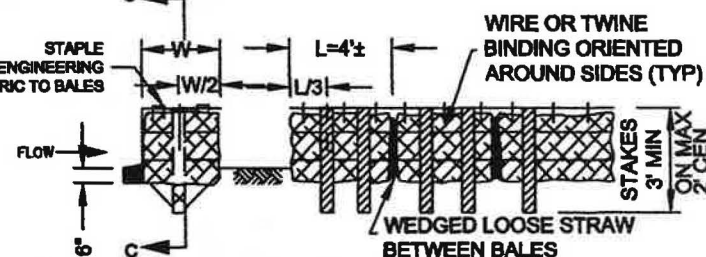
TEMPORARY SILT FENCE DITCH CHECK

NOTE:
POINTS "A" SHOULD BE HIGHER THAN POINTS "B" TO INSURE FLOW THROUGH OR OVER BARRIER, NOT AROUND IT.

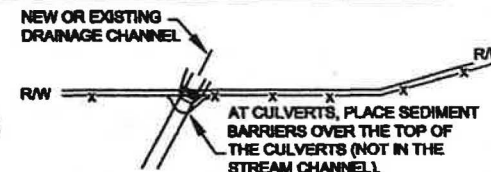
SEE PLANS FOR ESTIMATED NUMBER OF BALES.



DITCH APPLICATION DETAILS



TEMPORARY STRAW BALE DITCH CHECK



LOCATION DETAIL

- NOTE:**
1. ENGINEERING FABRIC MAY BE ELIMINATED ON STRAW BALES IF APPROVED BY ENGINEER.
 2. ENGINEERING FABRIC SHALL MEET SPECIFICATION REQUIREMENTS OF SILT FENCE FABRIC.

CITY OF PACIFIC, MISSOURI
Standard Construction Details

TEMPORARY EROSION
CONTROL MEASURES
TEMPORARY DITCH CHECKS

Dr. T.R.L. 2000 MD.08
Ch. R.L.B. Sh 5