

CHAPTER 9

STORM DRAINAGE

9-1 COUNTY POLICY AND REQUIREMENTS

- A. Using methods acceptable under County ordinances and Federal guidelines, the storm drainage system design shall be based on a drainage study that describes the improvements necessary to mitigate any adverse impacts of changed runoff caused by the project including changes to flow rate, quality, total volume and duration. The design of a new storm drain system shall include consideration of the downstream creek, conveyance channel or storm drain. The Design Engineer shall show that the existing storm water system can convey the proposed drainage without adverse flooding, erosion, sedimentation or other water quality impacts to upstream, downstream or adjacent facilities or areas; or that such facilities or areas are being improved or protected to the point where the drainage can be conveyed without adverse impacts.
- B. All submitted studies, plans, and calculations shall be signed and stamped by a Registered Civil Engineer prior to approval and all work shall be in accordance with these design standards and good engineering practice.
- C. All new structures shall be protected from the 100-year (1 %) flood event. All lowest floor elevations shall be set at least one foot (1.0) above all sources of 100-year flooding. If the elevation of the 100-year (1%) flood event is not available, it must be calculated by a Registered Civil Engineer. For arterial roadways, one lane of travel in each direction must be protected from the 100-year (1%) flood event and all public roads must be protected from the 10-year (10%) flood event by maintaining the hydraulic grade line a minimum of one-half foot (0.5') below the elevation of inlet grates and manhole rims.
- D. Private storm drain systems shall be clearly noted on the plans and maintenance responsibilities recorded in the covenants, conditions, and restrictions for each parcel.
- E. For areas that drain into existing storm drain facilities that were sized using previous standards, the Director may approve the use of alternative runoff rates or other modifications to the design standards.

9-2 STORMWATER UTILITY - The County maintains public drainage facilities within the Utility service areas and Sutter County Water Agency – Drainage Zones. New development in areas outside the existing Sutter County Utility service areas may be required to form a benefit assessment district or annex to a maintenance district for storm drain maintenance as required by the Director.

9-3 DRAINAGE FEES AND CREDITS – Developments may be required to participate in a zone of benefit drainage district or other public entity for financing the construction of a storm drainage capital-improvement system. Developments in an existing or future zone of benefit drainage district are subject to payment of a drainage impact fee, assessment, or other financing mechanism to facilitate the construction of a storm drainage system. Developments may be reimbursed for the construction of storm drainage facilities that benefit other properties. Reimbursement agreements shall be signed by the developer, and notarized, before approval of improvement plans. An approved zone of benefit study will define the drainage facilities eligible for reimbursement, the cost of those facilities, and the fair share cost for each property within the zone. Developers may be required to prepare the zone of benefit study.

9-4 FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) NATIONAL FLOOD INSURANCE PROGRAM

- A. Sutter County is a participant in the National Flood Insurance Program and all development in the County shall comply with the regulations of the Federal Emergency Management Agency (FEMA) and the County’s Floodplain Management ordinance. Petitions for a Conditional Letter of Map Amendment (CLOMA) or Conditional Letter of Map Revision (CLOMR) shall be submitted to Public Works and FEMA and approved by both entities before improvement plan approval.
- B. Petitions for a Letter of Map Amendment (LOMA) or Letter of Map Revision (LOMR) shall be submitted and approved by Public Works and FEMA before building permit issuance.
- C. Fill for the removal of land from the FEMA 100-year floodplain of a watercourse, where building pads will be created, must comply with the FEMA standards and must be compacted to 90 percent (90%) of the maximum density obtainable with the modified proctor test method (ASTM Standard D-1557) or an equivalent test method acceptable to the Director.
- D. These standards do not preclude the County from applying additional requirements under County Code or FEMA regulations. Required Federal fees shall be paid directly to FEMA by the applicant.

9-5 NOT USED

9-6 IMPACTS TO EXISTING DRAINAGE – All drainage must enter and leave the project area at its existing line and grade, unless otherwise approved by the Director. No net increase of peak flow is allowed. No net adverse impact for volume, quality or duration is allowed. No additional runoff may be directed towards County facilities or adjacent parcels. All impacts must be mitigated in the project area or lands acquired for mitigation by the project. Impacts must be evaluated using the 2-year, 10-year, and 100-year storms.

9-7 LOCATION OF FACILITIES AND LAND DEDICATIONS

- A. All drainage and storm drain facilities must be in the public road right-of-way or within land dedicated to the County in fee unless otherwise approved by the Director. Such parcels must be a minimum of 25 feet wide, sufficiently wide to accommodate normal construction equipment, and shall be easily accessible to such equipment as necessary to construct, operate, maintain and reconstruct the facility. Any area designated for public drainage facilities, including overland flow conveyance routes, and service roads, not confined to existing public right-of-ways shall be dedicated as a fee title parcel to the County. In rural areas, with approval of the Director, a drainage easement may be acceptable in lieu of land dedication. The County will not accept any conservation or other conditional easement on drainage courses to be conveyed to the County.
- B. Acquisition and maintenance of temporary construction easements outside of the limits of the subdivision shall be the developer's responsibility.
- C. Location and land dedication requirements specific to underground mains and open channels are further described below in this Chapter.

9-8 NOT USED

9-9 DESIGN SUBMITTALS

- A. As part of the design of a drainage system, a comprehensive drainage study must be prepared for review and acceptance by the Director. The comprehensive drainage study shall include but is not limited to: a detailed pre- and post-project hydrologic and hydraulic analysis of the project and project impacts; definition of the local controlling 100-year frequency water levels pre- and post-project; and the proposed method of flow conveyance with adequate supporting calculations. The study shall include any proposed improvements to mitigate the impacts of increased runoff from the project and any change in runoff including quality, peak flow, volume, and duration. The study shall be consistent with the ultimate upstream development in the General Plan and any specific, area, or master plans; and shall conform to these Design Standards. It shall demonstrate that the proposed methods of flow conveyance mitigate the potential project impacts. Study must be completed and stamped by a Professional Engineer, and determined by the County to be comprehensive, accurate, and adequate.

B. The drainage study submitted shall include, as a minimum, the following information and computations:

- Topographic map showing existing and proposed ground elevations.
- A shed map including on-site and off-site watershed boundaries draining onto the site. It shall also include land uses, total and sub-shed areas in acres.
- Quantity of flow (cfs) to each drainage inlet structure with corresponding area and land uses that generates the quantity.
- Quantity of flow (cfs) in each pipe.
- Flow line elevation of each manhole or junction structure.
- Top of structure rim or inlet grate elevation.
- Location of downstream outlet and hydraulic grade line at this location.
- Hydraulic grade line of the systems.
- The starting elevation for all hydraulic grade line calculations must be clearly noted on all plans and calculations. The source of this elevation must also be indicated (Master Plan, FEMA, etc.). If it is not readily available it must be calculated. If it is assumed, the basis of the assumption must be noted.
- Pipe size, material type, length and slope.
- Channel dimensions, flow and water surface profile computations.
- Overland Release hydraulic computations for street and non-street releases (including fence/wall openings and outlet).
- Analysis of permits required including type, processing time, and expected restrictions.

C. Improvement Plans must contain the additional features:

- Pipelines plans and profiles
- Open channel plans and profiles
- Phasing plans if all improvement are not constructed in the same time
- An overflow release map showing surface elevations and flow paths
- Notes concerning agreements and dedications

D. The applicant shall obtain applicable California Department of Fish and Game, U.S. Army Corps of Engineers, and other required state, federal, and local permits. The conditions of such permits must be reviewed and conditions considered acceptable by the County, before the permit is issued.

9-10 DESIGN RUNOFF. Computation of runoff shall be performed in the appropriate manner prescribed below.

A. Runoff shall be computed using one of the following methods:

- For calculations requiring development of a hydrograph(s), the Sacramento Method as described in Volume 2 of the Sacramento City/County Drainage Manual, HEC-1 or HEC-HMS may be used. Other appropriate methods may be used with approval by the Director.
- For calculations requiring only peak flows, the Sacramento Method Drainage Charts or Rational Method, or the hydrograph methods listed above may be used. Other methods may be used if approved by the Director.

B. For Sacramento Method calculations, the following apply:

- SacCalc is a Windows based software, available for free download that simplifies the preparation of HEC-1 models based on the Sacramento Method.
- The Nolte Method option presented in the SacCalc program may not be used.
- Sutter County is considered to be in Rainfall Zone 2.
- The runoff used in storm drain pipe design for drainage areas 160 acres and smaller may be computed from the Sacramento Method Drainage Charts included in these standards as drawings D-1 to D-4.
- Use Tables 9-1 and 9-2 to determine percentage of impervious cover, infiltration rates, and Basin 'n' values to be used in runoff calculations using the Sacramento Method and for use with the design flow curves in the standard drawings.

9-11 NOT USED

TABLE 9-1. IMPERVIOUS COVER PERCENTAGES AND INFILTRATION RATES BASED ON LAND USE AND SOIL GROUP

Cover/Land Use from Volume 2 Hydrology Standards	Equivalent Sutter County General Plan Land Use Designation ¹	% Impervious Cover	Infiltration by Soil Group (in/hr)		
			B	C	D
Highways, Parking		95	0.14	0.07	0.04
Commercial, Offices	Commercial	90	0.16	0.08	0.05
Intensive Industrial	Industrial	85	0.162	0.082	0.052
Apartments, HDR	High Density Residential	80	0.165	0.085	0.055
Mobile Home Park		75	0.167	0.087	0.057
Condominiums, MDR	Medium Density Residential	70	0.17	0.09	0.06
Residential: 8-10 du/acre, Ext Industrial	Medium Density Residential	60	0.18	0.10	0.07
Residential: 6-8 du/acre, LDR, School	Low Density Residential	50	0.18	0.10	0.07
Residential: 4-6 du/acre	Low Density Residential	40	0.18	0.10	0.07
Residential: 3-4 du/acre	Low Density Residential	30	0.18	0.10	0.07
Residential: 2-3 du/acre	Estate Residential	25	0.18	0.10	0.07
Residential: 1-2 du/acre	Estate Residential	20	0.18	0.10	0.07
Residential: 0.5-1 du/acre	Estate Residential	15	0.18	0.10	0.07
Residential: 0.2-0.5 du/acre, Ag Res	Agriculture Rural Community, Agricultural Preserve (residential)	10	0.18	0.10	0.07
Residential: <0.2 du/ac, Recreation	Parks & Recreation	5	0.18	0.10	0.07
Open Space, Grassland, Ag	Open Space, Agriculture	2	0.18	0.10	0.07
Open Space, Woodland, Natural	Open Space	1	0.19	0.11	0.08
Dense Oak, Shrubs, Vines	Open Space	1	0.25	0.16	0.12

1. In some cases, the General Plan designation encompasses more than one cover/land use type from the hydrology standards. The equivalent cover/land use type should be selected based on the actual proposed densities when known; otherwise an average value should be used.

TABLE 9-2. BASIN 'N' VALUES BASED ON LAND USE

Cover/Land Use from Volume 2 Hydrology Standards	Equivalent Sutter County General Plan Land Use Designation ¹	% Impervious Cover	Channelization Description	
			Developed Pipe/Channel	Undeveloped Natural
Highways, Parking		95	0.030	n/a
Commercial, Offices	Commercial	90	0.031	n/a
Intensive Industrial	Industrial	85	0.032	n/a
Apartments, HDR	High Density Residential	80	0.033	n/a
Mobile Home Park		75	0.034	n/a
Condominiums, MDR	Medium Density Residential	70	0.035	n/a
Residential: 8-10 du/acre, Ext Industrial	Medium Density Residential	60	0.037	n/a
Residential: 6-8 du/acre, LDR, School	Low Density Residential	50	0.040	n/a
Residential: 4-6 du/acre	Low Density Residential	40	0.042	n/a
Residential: 3-4 du/acre	Low Density Residential	30	0.046	n/a
Residential: 2-3 du/acre	Estate Residential	25	0.050	n/a
Residential: 1-2 du/acre	Estate Residential	20	0.053	n/a
Residential: 0.5-1 du/acre	Estate Residential	15	0.056	0.096
Residential: 0.2-0.5 du/acre, Ag Res	Agriculture Rural Community, Agricultural Preserve (residential)	10	0.060	0.100
Residential: <0.2 du/ac, Recreation	Parks & Recreation	5	0.065	0.110
Open Space, Grassland, Ag	Open Space, Agriculture	2	0.070	0.115
Open Space, Woodland, Natural	Open Space	1	0.075	0.120
Dense Oak, Shrubs, Vines	Open Space	1	0.080	0.150

1. In some cases, the General Plan designation encompasses more than one cover/land use type from the hydrology standards. The equivalent cover/land use type should be selected based on the actual proposed densities when known; otherwise an average value should be used.

9-12 CLOSED CONDUITS

A. Capacity and Hydraulic Grade Line

1. Pipe storm drain systems shall be designed to convey the peak flow rate from the 10-year storm.
2. Manning's formula shall be used to determine the pipe design parameters such as capacity, slope, hydraulic grade line, and velocity. Computations shall be based on the following Manning's roughness coefficients.

Precast Concrete Pipe	0.015
High Density Polyethylene Pipe	0.015
Polyvinylchloride Pipe	0.015
Concrete Box Culvert (within a closed conduit system)	0.016
Ribbed Metal Pipe	0.015
Concrete Cast-In-Place Pipe	0.015
Corrugated Metal Pipe 2-2/3" x 1/2" Corrugations	0.024
Corrugated Metal Pipe 3" x 1" or 5" x 1" Corrugations	0.028

3. Hydraulic grade line calculations for pipe storm drain systems shall begin at the worst case 10-year channel or basin water surface elevation. For the design flow, the hydraulic grade line shall be a minimum one-half foot (0.5') below the elevation of all inlet grates.
4. A note shall be made on the plans indicating stationing where the hydraulic grade line is below the soffit of the pipe.
5. The minimum inside diameter for pipes used in the public right of way shall be no less than twelve inches (12"). No storm drain conduit shall have a diameter less than that of the conduit immediately upstream of it.
6. In adjacent unimproved areas with no current development plans, the future gutter flow line is assumed one and one-half feet (1.5') lower than the natural ground elevation, for purposes of pipe hydraulics calculations. This also applies to in-fill development, where the elevation of the hydraulic grade line is not known.

B. Material. The specific type of pipe or alternate pipe to be used in the development shall be shown on the profile sheets. Publicly maintained drainage systems shall be constructed of the following materials and installed consistent with the latest edition of the Standard Construction Specifications:

1. Reinforced Concrete Pipe. Class of pipe shall be based upon depth as detailed in the Standard Drawings. Pipe shall conform to ASTM C76, latest revision. The consultant shall specify on the plans that the assembly

of joints shall be in accordance with the pipe manufacturer's recommendations and the requirements of ASTM C443.

2. Concrete Cast-In-Place-Pipe. Use of Concrete Cast-In-Place-Pipe is not permitted for use in storm systems to be owned, operated, and maintained by Sutter County.
3. Polyvinyl Chloride Pipe. Polyvinyl Chloride (PVC) Pipe may be used conforming to the Standard Specifications. Use of polyvinyl chloride downstream of the last manhole or junction structure to outfalls to channels or detention basins is not allowed.
4. High Density Polyethylene Pipe
 - a. HDPE shall not be used in existing or future roadways or for driveway culverts. It may only be used for trunk lines outside roadways.
 - b. Use of High Density Polyethylene Pipe downstream of the last manhole or junction structure to open channels, detention facilities or to a daylight condition is not allowed.
5. Metal Pipe
 - a. Metal pipe shall be corrugated steel, corrugated aluminum, corrugated aluminized steel Type II, ribbed steel, ribbed aluminized steel Type II or ribbed aluminum.
 - b. Metal pipe shall be designed for a minimum maintenance free service life of fifty (50) years in accordance with the methods specified in Section 854.3 and 854.4 of the California Department of Transportation Highway Design Manual. To assure that the service life is achieved, alternative metal pipe may require added thickness and/or protective coatings. The Design Engineer shall provide certified copies of the laboratory report giving the results of pH and resistivity tests. The report shall also include a map showing the location of each site and depth where samples were taken.
 - c. Unless otherwise specified by the Director, a minimum of two soil samples shall be taken for the first 1,000 lineal feet of pipe or fraction thereof on a project with a minimum of one additional sample being required for each additional 1,000 lineal feet of pipe or fraction thereof. The samples shall be taken along the approximate alignment and at the approximate depth of the pipe to be installed. Priority in sampling shall be given to trunk facilities.

- C. Cover Requirements. At locations where the minimum cover requirements cannot feasibly be obtained, the conduit shall be provided with a concrete cover or other methods of pipe protection as approved by the Director. Cover shall be

measured from the top of a rigid Portland cement concrete pavement or the bottom of a flexible asphalt concrete pavement structural section.

1. Minimum Cover - The minimum cover requirements shall be per Table 9-3 and measured from the top of pipe exterior to top of subgrade (bottom of A.B.).
2. Maximum Cover - Maximum height of cover shall be per Tables 9-4A and 9-4B.

TABLE 9-3. MINIMUM PIPE COVER REQUIREMENTS

Pipe Material Type and Location	Minimum Cover Requirement
High Density Polyethylene (HDPE) – non traffic areas	Twenty-four (24”) – top of pipe to top of grade
Corrugated Metal	Span/8 but not less than twelve inches (12”)
Spiral Rib – Steel	Span/3 but not less than twelve inches (12”)
Spiral Rib – Aluminum with spans less than or equal to 72”	Span/2 but not less than twelve inches (12”)
Spiral Rib – Aluminum with spans greater than 72”	Span/3 but not less than thirty inches (30”)
Reinforced Concrete in unpaved areas	1/8 the diameter or rise (the greater of) but not less than twelve inches (12”)
Reinforced Concrete under flexible pavements (Class IV and V)	1/8 the diameter or rise (the greater of) but not less than twelve inches (12”)
Reinforced Concrete under flexible pavements (Class I, II, and III)	1/8 the diameter or rise (the greater of) but not less than twenty-four inches (24”)
Reinforced Concrete under rigid pavements	A nine-inch (9”) space between top of pipe and bottom of slab consisting of compacted granular fill shall be maintained at a minimum.
Cast-in-Place-Concrete-Pipes in paved areas	The structural section (AC & AB) plus twenty-four inches (24”)
Cast-in-Place-Concrete-Pipes in unpaved areas	Twenty-four inches (24”)
Polyvinyl Chloride – C900 and C905	Twelve inches (12”)
Polyvinyl Chloride – D2241 and D3034	Twenty-four inches (24”)

Notes: 1. All depths shown are for a minimum trench width equal to the outside diameter of the pipe plus sixteen inches (16”) measured at the top of the pipe.

2. Top of pipe means the top of pipe exterior.

TABLE 9-4A. MAXIMUM PIPE COVER REQUIREMENTS – CONCRETE / PLASTIC PIPE

Measured to bottom of trench in feet

DIA	RCP					Cast In Place	PVC	HDPE		
	Class									
	I	II	III	IV	V					
12	Not Permitted	8	12	30	No Limit	No Limit	14	49		
15		10	15	35			14	45		
18		11	16	38			14	43		
21		12	17	39			14			
24		12	18	39			14	43		
27		13	19	39			14			
30		14	19	38						
33		14	20	38				34		
36		13	17	27			69		45	
42		14	18	29			62	38	46	
48		15	19	30			60	30	41	
54		16	20	31			58	26		
60		14	16	21			31	57	24	48
66		15	17	22			32	56	21	
72	15	18	23	33	56	21				

Note: All depths shown are for a minimum trench width equal to the outside diameter of the pipe plus sixteen inches (16”) measured at the top of the pipe.

TABLE 9-4B. MAXIMUM PIPE COVER REQUIREMENTS - METAL PIPES

Measured to bottom of trench in feet

DIA	CMP **					Ribbed Steel Pipe			Ribbed Aluminum Pipe			
	Thickness - inches					Thickness - inches			Thickness - inches			
	0.064	0.079	0.109	0.138	0.168	0.064	0.079	0.109	0.060	0.075	0.105	0.135
12	99	No Limits										
15	99											
18	99											
21	99	99										
24	93	99										
30	74	93										
36	62	78	99	99	30	40	56	17	24	40	51	
42	53	66	93	99	26	35	48	14	21	34	44	
48	46	58	81	99	21	31	41	13	18	30	37	
54	47	52	72	93	20	28	38	12	17	26	34	
60	43	53	65	84	19	26	34		15	25	31	
66	39	48	68	76		25	32		14	23	28	
72	35	42	62	70		22	30			21	26	
						22	28			20	25	

Note: 1. All depths shown are for a minimum trench width equal to the outside diameter of the pipe plus sixteen inches (16”) measured at the top of the pipe.

2. ** Normal pipe corrugation profile is 2 2/3” x 1/2”. The corrugation of the pipes within the shaded box area shall have profile of 3” x 1” or 5” x 1”.

3. When flow velocity exceeds five (5) feet per second, the next thicker gauge shall be used for CMP pipe.

D. Temporary Construction Vehicle Loading

1. A note shall be made on the plans stating the minimum cover requirements during construction for temporary heavy construction vehicle loading, such as scraper or truck haul routes.
2. For flexible pipes, place at least four feet (4') of cover over the top of the pipe.
3. For rigid pipes, place at least three feet (3') of cover over the top of the pipe.

E. Trench Requirements

1. Trenches shall be excavated with full depth and vertical sides whenever possible.
2. The minimum trench width shall not be less than the outside diameter of the pipe barrel plus sixteen inches (16"), measured at the top of the pipe. Where conditions require side sloping of trenches, the minimum vertical trench shall be from the bottom of the trench to one foot (1') over the top of the pipe.
3. In fill areas, or in areas with poor soil conditions where it is anticipated that a good, firm, vertical-walled trench cannot be constructed, the Design Engineer shall design the pipe structural requirements in accordance with good engineering practice. A note shall be placed on the plans directing the contractor to place the proper strength pipe if trench conditions encountered differ from those stated in the design trench plans.

F. Parallel Pipe Spacing Requirements. When multiple adjacent pipe lines are used, they shall be spaced so that the sides of the pipes shall be no closer than two feet (2'), or for parallel pipes larger than forty-eight inch (48") the spacing shall be no closer than one half (1/2) the nominal diameter of the largest pipe. This is to permit adequate compaction of backfill material. Special bedding and backfill considerations shall be taken when depths of parallel pipes vary.

G. Alignment Requirements

1. The location of storm drainage pipes in new streets shall be typically six feet (6') north or west of and parallel to the centerline of the street. In special situations, pipelines may be placed in alternative locations, including under curb and gutter, as approved by the Director.
2. All new storm drain mains shall be placed a minimum of fifty feet (50') from existing and proposed water wells. Encroachments less than fifty feet (50') require approval of County Planning and the water purveyor prior to plan approval.

Avoid unnecessary meandering and angular changes of pipelines. Angular changes, when necessary, shall not exceed 90 degrees unless approved by the Director. No angular changes in direction are allowed for concrete cast-in-place-pipe other than on a radius.

4. Pipeline Radius Criteria: All pipe placed on curves shall meet manufacturer's recommendations for curved alignment. All curves, radii, length of pipe joints, and types of pipe shall be shown on the plans. The minimum radius of curvature for concrete cast-in-place-pipe shall be determined by the formula $R = 30D$ where R = radius of curvature, and D = nominal internal pipe diameter, with R and D expressed in the same units.
 5. Pipelines shall be laid straight in both horizontal and vertical planes between manholes unless otherwise approved by the Director.
- H. Velocity. The minimum full flow velocity shall be no less than two (2) feet per second. The maximum velocity, at maximum pipe system capacity, shall not exceed 10 feet per second.
- I. Pipe Inlets and Outlets
1. Headwalls, flared end sections and other structures at inlets shall be designed to increase hydraulic efficiency, prevent erosion adjacent to the conduit and provide a counterweight to prevent flotation. Headwalls or flared end sections shall be used at both intake and discharge ends of culverts and pipes.
 2. At pipe outfalls into open channels, standard headwalls shall be installed per the Standard Drawings.
 3. The vertical face of the headwall shall be set back a sufficient distance from the channel side slope to accommodate flap-gates (when needed) in a fully opened position without encroachment of the flap past the channel side slope face.
 4. All pipe and culvert entrance and outlet locations must be provided a concrete apron with a minimum length of five (5) pipe diameters for erosion control and maintenance purposes.
 5. Pipe inlets greater than 24 inches will normally have a trash rack installed. Pipe outlets greater than 36 inches, not in an area enclosed with a fence, will normally have a trash rack installed for access control.
 6. Energy dissipaters must be utilized at outlets at the end of the concrete apron. All energy dissipation shall be designed considering outlet velocities and hydraulic jumps. Rip-rap shall not be placed on the outlet apron.

- J. Bored and Jacked Pipe. All casing pipes shall be sealed at both ends in such a manner as to provide water resistant seal.
- K. Backfill Seepage. A concrete filled cutoff barrier shall be utilized at inlets and outlets where there is a high probability that water will periodically penetrate pipe backfill material.
- L. Water and Soil Tight System
 - 1. All storm drain pipes, manholes, and fitting connections, including drain inlet laterals shall be water and soil tight and tested in conformance with the Standard Specifications.
 - 2. A note shall be placed on the improvement plans stating these requirements and that the contractor is responsible for providing equipment and labor for performing tests and making measurements when directed to do so by the County's inspector.
- M. Land Dedication. Drainage parcels, right-of-ways, or easements (if authorized) for closed conduits, shall meet the following criteria:
 - 1. Minimum width of the parcel/right-of-way shall be equal to the greater of twenty-five feet (25') or the required trench width according to the standard detail for pipe bedding and initial backfill (Standard Drawing D-5) plus two feet (2') of additional width for every foot of depth as measured from the bottom of the pipe to finished grade
 - 2. A minimum distance from the conduit to the edge of the parcel/right-of-way of ten feet (10') must be provided.

9-13 MANHOLES AND JUNCTION BOXES – Requirements for manholes are as follows:

- A. Standard pre-cast concrete or saddle type manholes shall be used except where special manholes or junction boxes are required. The design of special manholes and junction boxes must be submitted to the Director for approval. Cast-in-place manholes shall conform to the Standard Drawings.
- B. All manholes shall be a minimum 48 inches inside diameter unless approved on an exception basis by the Director. In no case will junction boxes or manholes be allowed which are smaller than twenty-four inches (24") inside dimension.
- C. Manholes shall be sized to provide a minimum of nine inches (9") wall spacing between annular cutout edges of pipe openings.
- D. Manholes shall be located at junction points, angle points greater than 15 degrees, and changes in pipe size or materials. On curved pipes with radii of 200-feet to 400-feet, manholes shall be placed at the beginning and end of curve and on 300-

feet maximum intervals along the curve. On curves with radii exceeding 400-feet, manholes shall be placed at the beginning and end of curves and on 400 feet maximum intervals along the curve for pipes twenty-four inches (24") and less in diameter and 500-foot maximum intervals along the curve for pipes greater than twenty-four inches (24") in diameter. Manhole spacing on curves with radii less than 200-feet will be determined on an individual basis. Exceptions to these calculated manhole placement shall be allowed if the resulting manholes are within 100 feet of existing or proposed manhole.

- E. Spacing of manhole, junction boxes (or inlets of such size as to be accessible for maintenance) shall not exceed 400-feet for drains fifteen inches (15") and smaller in diameter, 500-feet for drains between eighteen inches (18") and thirty-six inches (36") in diameter, and 600-feet for pipes greater than forty-two inches (42") in diameter.
- F. All manholes and junction boxes other than inlets shall have standard manhole frames and covers as shown in the Standard Drawings. Manhole and junction box covers shall be marked "STORM DRAIN" in raised lettering. Manholes will not be allowed in the gutter or sidewalk.
- G. A reinforced concrete forty-eight inch (48") diameter (no cone) flat top, as shown in the Standard Drawings, shall be required when any pipe would enter the manhole above any portion of the base of a manhole cone.
- H. Use grated manhole covers (Standard Drawing D-11) to pick up minor drainage in non-traffic areas only if debris clogging is not a concern.
- I. Improvement plans shall include a special detail for all manholes at junction points where there is a change in pipe direction for pipe diameters exceeding forty-eight inches (48").
- J. Resilient connectors, in conformance with Standard Drawing D-6 and the Standard Construction Specifications, are required between pre-cast manhole/box and pipe, and between pre-cast drop inlet and pipe. Water stops are required for pipe to cast-in-place manhole/drop inlet connections. Use non-shrinking/non-expansive grout for making connections of pipe and water stop to structure walls.
- K. Stations of manholes/boxes shown on project drawings apply at center line of shaft. Manhole/box lids shall be bolted to frame where lids are prone to surcharging when the storm drain system is at maximum capacity. A pressure manhole design may be required by the Director.
- M. Storm drain manholes/boxes shall be tested in conformance with the Standard Construction Specifications.
- N. There shall be no sumps in manholes outside of the public right-of-way. Manholes and junction boxes located outside of paved areas shall have rim set 0.5 feet above ground surface.

- O. Drop inlets shall not be used as junction boxes, unless approved by the Director.
- P. Junction boxes shall be constructed of pre-cast or cast in place reinforced concrete with minimum wall thickness of six inches (6"). The Design Engineer shall submit calculations indicating the junction box is designed to withstand HS-20 loading
- Q. The inside vertical dimension of junction boxes shall be such as to provide a minimum of three-inch (3") clearance on the outside diameter of the largest pipe in each face. Junction boxes shall have a minimum horizontal inside dimension of forty-eight inches (48"). All junction boxes shall be rectangular unless otherwise approved by the Director.
- R. Pipes adjacent to junctions shall have tight, impermeable joints subject to testing requirements of the Standard Construction Specifications.
- S. Junction boxes larger than ten feet (10') in any internal dimension shall have two manhole access points.
- T. Storm drain manholes/boxes shall be tested in conformance with the Standard Construction Specifications. All storm drain manholes shall be vacuum tested in accordance with ASTM C1244 and the Standard Construction Specifications.

9-14 INLETS

- A. All inlet design curves in these Design Standards assume clean inlets. The Design Engineer shall assume a 50% clogging factor when determining the number and location of inlets.
- B. Additional inlets may be required at sump locations. At sag points where the approaching gutter profile slope exceeds 2%, the inlets shall be sized to account for upstream bypass flows of at least 0.7 cfs/acre.
- C. Type B inlets are typically used for streets with concrete curbs and gutters. The maximum area allowed to drain to any one drain inlet is 2 acres.
- D. Always use grated inlets when the longitudinal slope of the street exceeds 4% where due to the high velocities it is difficult to direct the flows into the curb opening.
- E. Type F inlets may be used in roadside ditches, swales, unimproved medians, and outside of the road right-of-way. Figure 9-1 provides the design capacity for one two-foot wide window of a Type F inlet, clear of debris.
- F. Temporary pipe stubs shall be as deep as possible to provide for future extension, and raised to grade using a type F, type H, or type I inlet or other appropriate

catchments. Type H Inlets shall be sized two (2) sizes larger than the connecting pipe or pipe stub.

- G. Curb opening inlets (D-15) may be used in locations where additional inlet capacity, beyond a single Type B inlet, is needed, or as where directed by the Director. The inlet width may vary from seven feet (7') to twenty-eight feet (28'). The H dimension is the gutter depression depth and shall be a standard two inches (2"). When more than one grate is required, use Drawing D-16 for support assembly. Assure that the lateral is sized to serve the increased inlet capacity. Flow capacity for the curb opening inlets is calculated using the methods found in the Federal Highway Administration (FHWA) Urban Drainage Design Manual Hydraulic Engineering Circular No. 22.
- H. Inlets in Class "A" and "B" streets (as defined in Section 4-2) shall be placed at lot lines in residential subdivisions and at the curb return of intersections. Inlets shall be placed so that the length of flow does not exceed 500 feet, unless otherwise approved by the Director. Inlets at curb returns shall be constructed so that they are not in conflict with the Americans with Disabilities Act requirements for ramps. No face plates are allowed on inlets at the curb returns.
- I. Type F inlets shall be designed based on Figures 9-1 and 9-2. The chart assumes clean openings, so some clogging shall be accounted for by adding a grated lid or increasing the window opening(s).

TYPE F INLET FLOWS

FIGURE 9-1

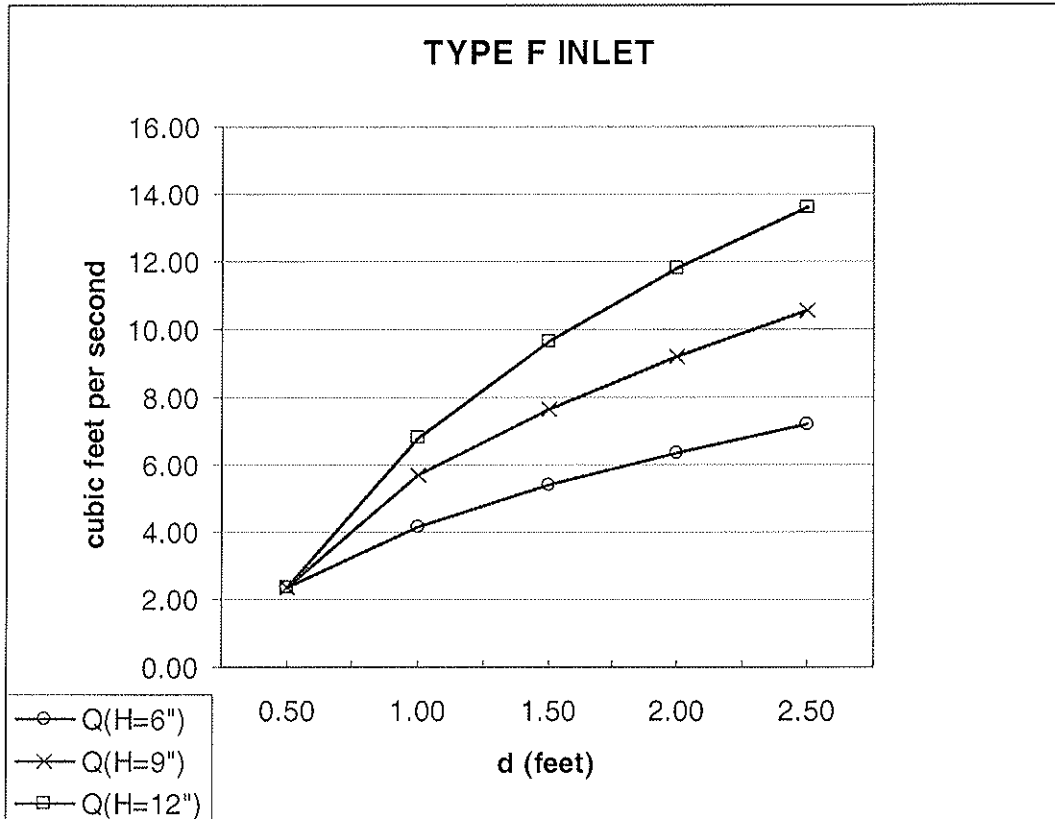
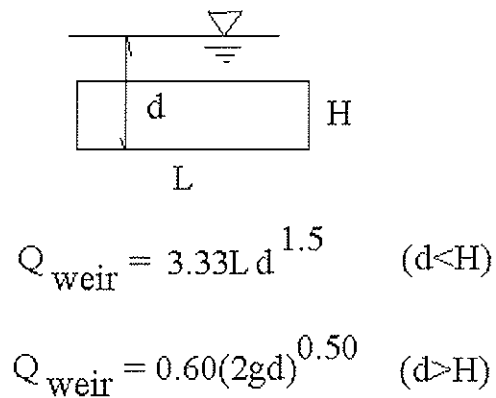


FIGURE 9-2



9-15 OVERLAND RELEASE – Piped storm drain systems are not designed to convey peak flow from infrequent high intensity storm events. When the pipes and inlets are overwhelmed, surface runoff will pond in low areas and flow overland along designed overland release routes. The improvement plans shall include overland release routing and the Design Engineer shall provide supporting calculations. Risk of flood damage shall be reduced by insuring that the 100-year storm runoff ponds and flows through the proposed development with appropriate freeboard protecting existing and proposed structures, pursuant to Section 9-1 of these Standards. Hydraulic and erosion control calculations for overland release flows must be provided with the design.

- A. For purposes of overland flow design, the designer may assume the storm drain pipes are flowing full into 100-year downstream water surface condition, or may actually calculate the flow conditions using the 100-year storm event with a 10-year HGL as the starting water elevation for the downstream channel.
- B. Arterial streets and selected collector streets, as determined by the Director, will be designed with at least one traffic lane in each direction completely above the 100-year HGL elevation.
- C. Where the overland release path leaves the paved right-of-way, concrete improvements shall be constructed as a mow strip, gutter or other permanent flow line. Decorative use of stamped concrete is encouraged. The use of grouted paving stones or cobbles is acceptable as long as they are placed on top of a two (2) inch minimum concrete base, are solid grouted, and do not protrude into the invert elevation/flow line. The outlet of the overland release flows must be similarly armored with a concrete apron. Additionally, energy dissipation features must be placed at the end of the apron and/or formed within the apron concrete.
- D. Streets, publicly-owned parking lots, pedestrian areas, pedestrian walkways, utility routes and other open space areas may be considered compatible uses for the overland release routing. Appropriate barricades for traffic safety and signage as required by the County shall be placed as needed for release paths exiting the right-of-way.

9-16 NOT USED

9-17 HEADWALLS AND RACKS – The requirements for headwalls, wing-walls, end walls, trash racks, access control racks and railings are as follows:

- A. All headwalls, wing-walls and end walls shall be considered individually and in general shall be designed in accordance with these Standards and the State Standard Plans and State Standard Specifications.
- B. Erosion control is of high importance where storm drain pipes discharge to natural channels. Energy dissipating structures shall be detailed on the improvement plans. Pipe and culvert entrance and outlet locations shall be provided a concrete apron with minimum lengths as required in Sections 9-12, H and 9-14, F for erosion control and maintenance purposes.

- C. Trash racks will be provided on inlets to pipes entering an underground conduit system. Pipe inlets greater than 24 inches will normally have a rack installed.
- D. Racks shall be required on pipe outlets forty-two inches (42”) or larger, unless access is restricted by fencing and omission is approved by the Director. The Director may require racks at smaller pipe outlets in locations that are deemed to warrant supplemental access control. Racks will not normally be installed on open-ended culverts.
- E. Racks shall be designed such that the ratio of rack open area to drain opening is at a minimum four to one (4H:1V).
- F. Public safety may require metal beam guardrail or chain link fencing at the top of culverts, headwalls, box culverts, and steep side slopes. Installation shall be in accordance with the Standard Construction Specifications and the Standard Drawings.
- G. Slopes around headwalls, wing walls, end walls, trash racks and other concrete structures shall be protected from erosion appropriately.

9-18 DRAINAGE PUMPS – Drainage pumping stations shall be designed in accordance with the latest edition of the Hydraulic Institute Standards and as specified by the Director. A pump station will include the following minimum features:

- A. A standby backup pump.
- B. A trash rack with an automated debris removal system at the inlet.
- C. A diesel powered generator with automated start and stop and a 24 hour supply of fuel.
- D. A low flow pump.
- E. Automated control systems linked to a SCADA system.
- F. In most cases the pump station shall include a building to house the electrical equipment, backup generator, and to provide a storage area.

The County will provide a list of additional required features based on the size, location and purpose of each station.

9-19 DETENTION SYSTEMS – Detention basins can be used for peak flow attenuation, detention, and retention and/or storm water treatment. Flood control detention system designs must be performed for all detention/retention basins, temporary or permanent.

- A. Flood control detention basin volume requirements shall be determined based on a 100-year storm. Detention systems shall be evaluated for storm durations of 24-

hours and 10-days and the worst case duration shall govern the design. Flood control detention basins shall be designed with a minimum of 1 foot of freeboard. For detention basins with levees, a minimum freeboard of 3 feet shall be provided. The total volume required for the basin shall be based on hydrologic routing computations. Basin routing curves shall be included in the submitted design calculations.

- B. Side slopes of the basin and any berm shall be no steeper than 3H:1V. Shape should be irregular and slopes should vary around the basin to give it a more natural appearance, up to approximately 10H:1V slopes. Bottom of the basin must slope towards outlet at a minimum 2% slope if vegetated or 0.5% if paved.
- C. The bottom of the basin shall be a minimum of 2 feet above the highest seasonal ground water elevation and be based on the recommendation of a licensed engineering geologist or soils engineer. A clay or concrete liner may be required to prevent groundwater intrusion into the basin.
- D. If a water quality structure is included in the basin design, the volume of the water quality portion of the basin will be in addition to the volume required for detention. The water quality element of the basin must be designed according to the above referenced design standards and the Stormwater Quality Design Manual for the Sacramento and South Placer Region.
- E. Approved detention basins shall require submittal of a “User Manual” for each detention basin. This manual shall include an 11”x17” sheet showing details of the detention basin including: inlets, outlets, ramps, elevation, and a vicinity map showing the access route from the arterial and the 10- and 100-year elevations.
- F. Fencing shall normally be required around detention basins. The specific design and materials used are subject to the approval of the Director. The minimum requirements for fencing are as follows:
 - Fencing shall be six foot (6’) chain link or “decorative” style, located six inches (6”) inside of right of way or easement.
 - Pedestrian gates shall be four feet (4’) wide.
 - Vehicle gates shall be two eight foot (8’) gates with a total opening of sixteen feet (16’) wide. They shall be set a minimum of twenty feet (20’) back from the edge of pavement to allow for a safe parking area off of the traveled way while opening and closing the gates. Gates must swing away from road right-of-way. A concrete driveway shall be provided at vertical curb locations. Asphalt concrete paving shall be provided between the traveled way and drive gate.
 - Signs may be required as considered appropriate by the Director. As a minimum, the vehicle gate access shall be marked “Sutter County Drainage Facility – No Motorized Vehicles - No Parking”. Signage statements, sizes, layout, and colors shall be approved by the Director.
 - Fencing and gates components shall be composed of unpainted galvanized steel. Other materials such as aluminum, or other approved durable and corrosion-

resistant materials may be used if decorative fencing is required for the area. Weld joints shall be cleaned and covered with a zinc-based coating.

G. Access Roads are required around detention basins for maintenance, normally located at or above the 100-year flood elevation. An area with a minimum width of 25 feet shall be set aside for access.

- A twenty foot (20') service road shall be provided having a sixteen foot (16') improved surface and two foot (2') shoulders on each side. Curve radii shall be a minimum of forty-two feet (42'). Turnouts shall be placed as dictated by horizontal sight distance and shall be no greater than one-thousand feet (1,000').
- For roads with no outlet, a turn-around shall be constructed with a minimum 40 foot outer radius at the end of the road.
- Improved surfaces of the service road shall be a minimum six inches of AB. Existing sub grade shall be compacted to 95% and AB will be compacted to 90%.

H. Access ramps are required to the bottom of detention basins that are more than 4 feet below the access road to allow access for emergency and maintenance equipment.

- The minimum width shall be twelve feet (12') at a maximum slope of ten percent (10%). See Drawing D-24.
- Ramps will be constructed of concrete; minimum 4 inches thick with appropriate base (may be colored to blend with the surroundings). Attention to both aesthetics and serviceability is required. Materials with characteristics similar to concrete may be substituted on an exception basis if authorized by the Director.
- Details of the ramps shall be shown on the improvement plans.

9-20 OPEN CHANNELS – All runoff for new development must normally be conveyed in closed conduits. Open channels may be authorized by the Director whenever one or more of the following applies:

- The design flow rate exceeds the capacity of a seventy-two inch (72") pipe.
- The outfall is at an elevation such that minimum cover cannot be obtained over the pipe.
- County, State or Federal Government policies require that the channel remain natural. A parallel facility for runoff conveyance may be considered. If an agreement is needed between a State and Federal Agency, such agreement must be approved by the Director prior to its submittal to other agencies.

Open channels are to be designed pursuant to the drainage study provided by the design engineer and to the satisfaction of the Director. Each project has unique hydraulic constraints and storm water quality requirements; therefore, the following should be deemed guidelines.

A. Open channels may consist of vegetated earth channels. Concrete lining may also be used.

B. Criteria for open channels shall be as follows:

1. Open channel design shall include a water surface profile analysis using the Army Corps of Engineers HEC-RAS computer program or other steady or unsteady state hydraulic program, approved by the Director.
2. Open channels shall be designed to convey the 100-year flood event with a minimum one foot (1') of freeboard. Greater freeboard may be required depending on the sensitivity of the model, obstructions, and surrounding property.
3. For open channel systems, the hydraulic grade line shall be shown for the 10-year and 100-year design flows. Prior to acceptance of all channels, bridges or culverts the 10- and 100-year hydraulic grade line elevations must be permanently marked on the structure.
4. The minimum 'n' values to be used in the Manning's formula for open channel design calculations shall conform to the following:

Open Channel Fully Lined with Concrete	0.018
Open Channel with Concrete Lined Bottom, Clean Sides	0.035
Earth Channel - Uniform shape with vegetated bottom and sides	0.060
Earth Channel with natural bottom and sides	0.080 or higher

5. The minimum velocity for open channels is 2.0 ft/s. The maximum velocity shall be as shown in Table 9-5:

TABLE 9-5. PERMISSIBLE VELOCITIES FOR UNLINED CHANNELS (ft/sec)

Type of Material in Excavation Section	Permissible Velocity (ft/s)	
	Intermittent Flow	Sustained Flow
Fine Sand (Noncolloidal)	2.5	2.5
Sandy Loam (Noncolloidal)	2.5	2.5
Silt Loam (Noncolloidal)	3.0	3.0
Fine Loam	3.5	3.5
Volcanic Ash	4.0	3.5
Fine Gravel	4.0	3.5
Stiff Clay (Colloidal)	5.0	4.0
Graded Material (Noncolloidal)		
Loam to Gravel	6.5	5.0
Silt to Gravel	7.0	5.5
Gravel	7.5	6.0
Coarse Gravel	8.0	6.5
Gravel to Cobbles (Under 6 in)	9.0	7.0
Gravel and Cobbles (Over 8 in)	10.0	8.0

6. Super elevating the outside bank on bends may be required to maintain specified freeboard.
7. The centerline curve radius of an open channel shall be equal to the greater of twice the bottom width or thirty-five feet (35').
8. Earth channels and the side slopes of bottom lined channels shall be vegetated with native grasses or other permanent vegetative cover. All vegetation shall be approved by the Director. Hydro-seeding conducted during the wet season (October 1 – April 30) shall include additional appropriate soil stabilization materials to prevent erosion. A note shall be added to improvement plans stating "Vegetated open channels shall not be accepted by the County until 70% of the vegetation is established." No trees shall be planted below the 10-year hydraulic grade line. Trees shall only be allowed below the 100-year hydraulic grade line when the channel is designed to preserve adequate conveyance capacity with trees present. Selection and location of trees must be approved by the Director.
9. Channels, deeper than two feet (2'), shall be constructed to a typical cross section with 3H:1V or flatter side slopes. Channels immediately adjacent to a road shall be designed with a side slope of 4H:1V or flatter. Exceptions require a soils report and the approval of the Director.
10. All channels deeper than 2 feet shall have a minimum bottom width of six feet (6').
11. Permanent erosion protection shall be placed at the top of the cut or bank to prevent erosion (see Standard Drawings). At locations where overland flows enter the channel, appropriate erosion control and energy dissipation methods shall be incorporated into the design.
12. For all channels, either improved or natural, the following items shall be shown on improvement plans in addition to information heretofore required:
 - a. Typical sections and cross-sections.
 - b. Profile of the existing channel and top of bank profile including enough of the existing channel each side of the development to establish an average profile grade through the development.
 - c. Ten and one-hundred year water surface elevations.
 - d. Road crossings with road profile indicating overland release.

13. In developed areas, fencing shall normally be required along both sides of open channels. The specific design and materials used are subject to the approval of the Director. The minimum requirements for fencing are as follows:
 - a. Fencing shall be six foot (6') chain link or "decorative" style, located within right of way or easement.
 - b. Pedestrian gates shall be four feet (4') wide.
 - c. Vehicle gates shall be two eight foot (8') gates with a total opening of sixteen feet (16') wide. They shall be set a minimum of twenty feet (20') back from the edge of pavement to allow for a safe parking area off of the traveled way while opening and closing the gates. Gates must swing away from road right-of-way. A concrete driveway shall be provided at vertical curb locations. Asphalt concrete paving shall be provided between the traveled way and drive gate.
 - d. Signs may be required as considered appropriate by the Director. As a minimum, the vehicle gate access shall be marked "Sutter County Drainage Facility – No Motorized Vehicles - No Parking". Signage statements, sizes, layout, and colors shall be approved by the Director.
 - e. Fencing and gates components shall be composed of unpainted galvanized steel. Other materials such as aluminum, or other approved durable and corrosion-resistant materials may be used if decorative fencing is required for the area. Weld joints shall be cleaned and covered with a zinc-based coating.

14. Access Roads are required on both sides of open channels for maintenance, normally located at or above the 100-year flood elevation. An area with a minimum width of 25 feet shall be set aside for access.
 - a. A twenty foot (20') service road shall be provided having a sixteen foot (16') improved surface and two foot (2') shoulders on each side. Curve radii shall be a minimum of forty-two feet (42'). Turnouts shall be placed as dictated by horizontal sight distance and shall be no greater than one-thousand feet (1000').
 - b. For roads with no outlet, a turn-around shall be constructed with a minimum 40 foot outer radius at the end of the road.
 - c. Improved surfaces of the service road shall be a minimum six inches of AB. Existing sub grade shall be compacted to 95% and AB will be compacted to 90%.

15. Access ramps are required to the bottom of open channels that are more than 4 feet below the access road to allow access for emergency and maintenance equipment. Each segment of a channel shall be accessible. Ramps shall be located in pairs where possible to allow entrance and exit of equipment.
 - a. The minimum width shall be twelve feet (12') at a maximum slope of ten percent (10%). See Drawing D-24.
 - b. Ramps will be constructed of concrete; minimum 4 inches thick with appropriate base (may be colored to blend with the surroundings). Attention to both aesthetics and serviceability is required. Materials with characteristics similar to concrete may be substituted on an exception basis if authorized by the Director.
 - c. Details of the ramps shall be shown on the improvement plans.

9-21 OUTFALL PLANS – Requirements for outfall plans are as follows:

- A. All permanent and temporary drainage outfalls shall be shown in both plan and profile on the improvement plans for a distance until a definite “daylight” condition is established.
- B. The profiles shall include ditch flow-line and left and right top of bank elevations.
- C. When improvements have more than one unit or phase, the drainage outfall shall be shown as extending to the property boundary and beyond, if required, although it may not be constructed with the current unit development.

9-22 NOT USED

9-23 CROSS CULVERT CRITERIA – The following standards apply when the 100-year water surface elevation is not freely spanned by a bridge:

- A. Cross culverts for minor sheds shall be designed in accordance with procedures outlined in the U.S. Department of Transportation “Hydraulic Design of Highway Culverts,” Hydraulic Design Series No. 5, September, 1985. For shed areas greater than 160 acres, use HEC-RAS or other software approved by the Director.
- B. Cross culverts shall be checked against 100-year runoff to assure that no adverse effect will occur upstream or downstream.
- C. Cross culvert profile will be determined by an examination of the overall profile of the channel for a minimum distance of 500-feet on each side of the installation, assuring that freeboard requirements are met, and inlet or outlet control shall be determined.
- D. Where no overland release is possible, cross culverts shall be oversized by at least twenty five percent (25%).

- E. Where roads are not to be overtopped, for public safety or physical constraints, the box culvert soffit shall have one-foot (1') of freeboard over the 100-year water surface elevation.
- F. Culverts shall include a headwall or flared end section at both the upstream and downstream end. A concrete apron shall be provided at the inlet and outlet of a culvert, with the minimum length of the lesser of 20 (twenty) feet or five (5) pipe diameters.

9-24 DRAINAGE IN RURAL AREAS – Drainage ditches may be used for runoff collection and conveyance along public right of ways in rural residential areas zoned for agricultural/residential lots at least 2 acres in size. Non-roadside ditches shall use the criteria for open channels and may require private easements to be recorded for cross lot drainage.

When appropriate, open roadside ditches shall use the criteria for design of Class “C” streets and the following requirements:

- A. Roadside ditches shall be sized to convey design runoff. Analysis of 100-year flows shall be considered per Section 9-1. Analysis shall include culverts. The 10-year and 100-year hydraulic grade lines shall be shown on the profile. A minimum grade of 0.3% or a minimum velocity of 2 ft/second shall be required.
- B. Roadside ditches shall use 4H:1V or flatter side slopes. Roadside ditches, including slopes, shall be located within the right-of way, where feasible. A drainage easement shall be dedicated for that portion of a ditch that extends beyond the standard right-of-way width..
- C. Driveway culverts shall be designed to pass the greater of the 10-year design runoff, the roadside ditch capacity, or a 12 inch minimum diameter. Culverts shall be constructed out of CMP or RCP pipe. Culverts shall be installed with either a six inch (6”) thick concrete collar and headwall; or shall extend at least 1 foot beyond the driveway slope and include a flared end section at the upstream and downstream ends.

9-25 STORMDRAIN SYSTEMS IN PRIVATE STREETS – Private storm drain systems that connect to County maintained drainage facilities shall have a manhole on private property immediately upstream of the connection within the public easement or right-of-way.

- A. It shall be made clear on the plans which facilities are privately owned.
- B. Private storm drain pipes serving more than two parcels shall be built per these Design Standards.

9-26 NOT USED

9-27 NOT USED