

SECTION 10: DRAINAGE

10-1 GENERAL

This Section is formulated to clearly define acceptable drainage analysis and design criteria for development in the City of Roseville. Drainage facets not covered in this Section shall conform to the Placer County Flood Control and Water Conservation District “Stormwater Management Manual” (SWMM), latest edition, and good engineering practice.

The City of Roseville has adopted storm water quality design standards to reduce water pollution generated by urban runoff, including trash capture requirements. These design standards are detailed in the West Placer Storm Water Quality Design Manual. This Manual is available on-line at the City of Roseville’s website <https://roseville.ca.us> Storm water design calculations and an operations and maintenance plan shall be made a part of the drainage report.

10-2 CITY POLICIES AND REQUIREMENTS

All residential lots shall have minimum pad elevations of one foot above the 100 year water surface elevation and all commercial sites shall have minimum finished floor elevations of one foot above the 100 year surface elevation assuming failure of the drainage system. This requires the Consulting Engineer to provide an overland release for all projects or provide storage for the 100-year storm frequency.

The overland release path shall be constructed in a manner to transport the peak rate runoff from the 100-year storm frequency through the site assuming all storm drains are inoperative, all upstream areas are fully developed, and that antecedent rainfall has saturated the tributary watershed. Streets, parking lots, playgrounds, pedestrian areas, pedestrian walkways, utility easements, and other open space areas may be considered compatible uses within the overland release path.

Except for single family or duplex residential lots, site drainage shall be collected on-site and conveyed via an underground storm drain system to approved existing storm drainage system without flowing into existing street gutters or existing roadside ditches.

Unless regional storm water mitigation devices are available specific mitigation shall be required for the project, shall be located on-site, and shall be maintained by the landowner.

10-3 DEVELOPMENT IN OR ADJACENT TO A REGULATORY FLOODPLAIN

The City’s Regulatory Floodplain boundaries are defined in the City’s General Plan – Safety Element. They are not the same as the flood hazard area shown on FEMA’s Flood Insurance Rate Map (FIRM). For the most part the Regulatory Floodplain is the land inundated by the 100-year flood event, assuming build-out of the drainage basin, with a total drainage area of greater than 300 acres. Precise boundaries shall be as approved by the Public Works Director.

Residential lots developed in or adjacent to the City’s Regulatory Floodplain shall have pad elevations a minimum of two feet above the City’s 100-year flood elevation. Non-residential projects shall have finished floor elevations a minimum of two feet above the City’s 100-year flood

elevation. A Letter Of Map Amendment (LOMA), a Letter Of Map Revision (LOMR) or LOMR based on fill (LOMR-F) is required for any development in or adjacent to the flood hazard area as shown on a Flood Insurance Rate Map. Elevations Certificates are required for such non-residential structures. In areas where the 100-year flood depths (measured at centerline of creek) are less than eight feet within the infill area on Cirby Creek, Strap Ravine, and Pleasant Grove Creek South Branch Sierra View Tributary, the above freeboard requirements is increased to a minimum of three feet.

In the case of no-grade or contour grade lots, located adjacent to the City's Regulatory Floodplain, and where a portion of the lot may become inundated with the 100-year storm event, a standard Guarantee letter shall be submitting to the Engineering Division prior to plan approval, or issuance of a building permit. The Guarantee letter shall be submitted by a Registered Civil Engineer or Land Surveyor licensed in the State of California and confirm that the lowest ground elevation adjacent to the building foundation meets the minimum requirements for pad elevations as described above.

If a tentative project is submitted which shows fill or other significant improvements within the Regulatory Floodplain, a hydraulic study shall be required to determine the effect of the encroachment. Encroachment shall not result in any off-site increase in water surface elevation. The Consulting Engineer should contact the City of Roseville's Floodplain Management Division to ascertain what existing studies, if available, should be used as a base model for the proposed development. The Consulting Engineer is responsible for assembling the necessary data and presenting the study to the City for review. The study should reflect ultimate build-out conditions of the watershed. When submitting plans that show improvements in the floodplain, the Consulting Engineer must submit a "Compliance Statement", stating that the proposed improvements shown on the plans are accurately reflected in the approved hydraulic study. A sample of the "Compliance Statement", the hydraulic study submittal requirements, and sample Hydraulic Study Worksheets are provided in the attachments at the end of this section.

Parking lots and storage areas shall be no more than 1.5 feet below the 100-year water surface elevation.

When developing property inundated by the City's Regulatory Floodplain, the portion of property that extends into the floodplain shall be dedicated to the City in fee or as a Flood Water Conservation Easement as determined by the Engineering Division. In areas where the floodplain has been dedicated as part of a Specific Plan but the 100-year flood levels are shown to extend slightly outside this dedicated floodplain area, the development shall fill the property located outside the dedicated floodplain to an elevation that is a minimum of two feet higher than the 100-year flood elevation, or incorporate that area into the floodplain.

All development in the City's Regulatory Floodplain shall comply with the regulations of the City's Flood Damage Prevention Ordinance and the City's General Plan.

NOTE: Design requirements for bike paths within the floodplains are provided in the section entitled “Bikeways” of these Design Standards.

10-4 FEDERAL FLOOD PROGRAM

The City of Roseville is a participant in the National Flood Insurance Program (NFIP) and all development in the City shall comply with the regulations of the Federal Emergency Management Agency (FEMA) and the City’s Flood Damage Prevention Ordinance.

Amendments of the FEMA flood maps will be required of all new developments located in a FEMA flood zone. Petitions for Letter of Map Amendment, including any fee required by FEMA, shall be submitted to the Public Works Department prior to approval of the improvement or site plans. For further information regarding these requirements, contact the City of Roseville’s Floodplain Management Section.

10-5 DRAINAGE DIVERSIONS

The diversion of natural drainage is allowable only within the limits of the proposed improvement. All drainage must enter and leave the improved area at its original horizontal and vertical alignment unless an agreement, approved by the City Attorney, has been executed with the affected property owners. Temporary drainage diversions during construction shall be approved by the City Engineer and shall be located and constructed in such a fashion as to permit their removal when necessary for the prevention of damage to adjoining properties.

10-6 DRAINAGE EASEMENTS

Publicly owned drainage conduits and channels will not be allowed on private property unless they lie within a dedicated public drainage easement. Where minor improvement of an existing channel falls on adjacent property (such as day lighting a ditch profile) a notarized right-of-entry from the property owner(s) for such construction shall be required. A copy of the document, which grants such approval, shall be submitted to the City Engineer prior to the approval of the improvement plans.

A. Easements for closed conduits shall meet the following width criteria:

- 1.** All easements for closed conduits shall have a minimum width in feet equal to the required trench width according to the standard detail for unshored trenches and excavation backfill plus two (2’) additional feet of width for every foot of depth as measured from the bottom of the pipe to finish grade. All conduits shall be centered within their easements.
- 2.** Minimum width of any easement for closed conduit shall be 15 feet.
- 3.** Easements adjacent to property lines shall be located entirely on one parcel.

B. Drainage easements for open channels shall have significant width to accommodate the following criteria:

1. Contain the channel and channel slopes.
 2. Provide for fencing, where required.
 3. A 15-foot wide service road and maintenance access ramps. A service road may not be required where the channel bottom is lined and a suitable access ramp is provided. Dedication of easements shall be completed and submitted to the City Engineer with copies of deeds or title reports for the affected properties before improvement plans will be approved.
- C. Open channels (natural or man-made) with a drainage area that exceeds 300 acres shall have the 100-year water surface elevation limits dedicated to the City in-fee or as Flood Water Conservation Easement.

10.7 DRAINAGE CAPACITY/DESIGN

All drainage systems shall be designed to accommodate the ultimate development of the entire upstream watershed. The 10-year peak storm discharge shall be used in the design of local drainage systems. In addition, other facilities such as streets, bridges, open channels, and buildings have requirements that relate to the 25 and 100-year peak storm discharge. The Consulting Engineer shall calculate the 10, 25, & 100-year peak discharge and submit these calculations along with the plans for all proposed drainage systems.

10-8 DESIGN PEAK DISCHARGE METHODS

The acceptable methods for the determination of runoff quantities for the 10, 25, & 100-year peak discharge are specified in the most recent edition of the Placer County Flood Control and Water Conservation District's (PCFCD) "Stormwater Management Manual" (SWMM). The SWMM allows for the "Unit Peak Discharge" method which is based on the relationship between the characteristic watershed response time and peak flow per unit area from precipitation patterns typical for the region, and provides a rapid evaluation of the peak flow rate from small watersheds (less than 200 acres). This method is presented in this section.

The SWMM also allows a HEC (Hydraulic Engineering Center) hydraulic analysis for watersheds larger than 200 acres. The HEC analysis must conform to the requirements of the most recent edition of the SWMM. All HEC analysis shall have the City's "HEC Hydraulic Study" Worksheet completed and included with the study. Sample worksheets and submittal requirements are provided at the end of this section.

10-9 UNIT PEAK DISCHARGE METHOD

A. Criteria: Peak flow is a product of watershed area and peak discharge per unit area, which, in turn, is a function of a completed response time.

$$Q_p = qA \quad \text{[Equation 10-1]}$$

Where:
 Q_p = peak discharge (cfs)
 q = unit peak discharge (cfs/acre)
 A = area (acres)

B. Response Time: Response time (t_r) an indication of the response time of the watershed to intense precipitation. It is determined as the sum of separate response times for a path consisting of the initial, overland sheet flow and succeeding collector flows from the most hydraulic remote location in the watershed to the watershed outlet.

- 1. Overland Flow:** Overland flow includes flow over planar surfaces such as roofs, streets, lawns, parking lots and fields. The overland flow length is not always well defined in natural areas, but usually becomes concentrated in shallow rivulets or swales within no more than 300 feet. In areas with development, the point at which the overland flow is concentrated in a collector, such as a gutter or pipe, is usually identifiable. Acceptable overland flow response times for various land uses are as follows. These times should be reduced to $0.90 * t_{ro}$ in 25 year events and 0.70 in a 100 year events.

OVERLAND RESPONSE TIME: Table 10-1

LAND USE	OVERLAND RESPONSE TIME
Low Density Residential	15 minutes maximum
Medium or High Density Residential	10 minutes maximum
Commercial / Industrial	10 minutes maximum

Equation 10-2 is used to estimate the overland flow component of response time.

$$t_{ro} = \frac{.355(nL)^{0.6}}{s^{0.3}} \quad \text{[Equation 10-2]}$$

Where:
 t_{ro} = overland response time (minutes)
 n = Manning's roughness coefficient (Table 10-2)
 L = flow length (feet)
 s = slope of surface (feet/feet)

MANNING’S ROUGHNESS COEFFICIENT: Table 10-2

SURFACE	n
Smooth surfaces (concrete, asphalt, or bare soil)	.011
Grass: Short Grass Prairie	0.15
Dense Grasses	0.24
Bermuda Grass	0.40
Poor grass cover on moderately rough surface	0.40
Woods with underbrush	0.40 – 0.80

2. Collector Flow – Manning’s equation shall be used for estimating collector response time (t_{rc}). The velocity computed for open channel flows using Manning’s equation shall be increased by an adjustment factor as follows to account for celerity:

CELERITY FACTOR: Table 10-3

CHANNEL SECTION	CELERITY FACTOR
Triangular	1.33
Wide Rectangular	1.67

In natural watersheds, it may be appropriate to use higher values of Manning’s “n” for the initial collector where the flow is shallow.

- C. Unit Peak Discharge:** Unit peak discharge is computed from the response time, t_r and equation 10-3 as follows:

$$qu = c_0 t_r^{C_1} \quad [\text{Equation 10-3}]$$

Where: qu = peak unadjusted unit discharge (cfs/acre)
 $t_r = t_{r0} + t_{rc}$ = response time (minutes)
 C_0, C_1 = coefficient from Table 10-4

COEFFICIENT FOR UNIT PEAK DISCHARGE: Table 10-4

Return Period (Yrs)	$t_r < 20$ minutes		$t_r > 20$ minutes	
	C_0	C_1	C_0	C_1
10	5.80	-0.50	17.80	-0.87
25	7.54	-0.50	23.14	-0.87
100	9.28	-0.50	28.48	-0.87

- D. Infiltration Factor:** The effect of infiltration is reflected in the infiltration factor F_i . F_i is found from the infiltration rate and Equation 10-4 as follows:

$$F_i = 1.7I \text{ [Equation 10-4]}$$

Where: F_i = infiltration factor (cfs/acre)
 I = infiltration rate (inches/hour, Table 10-5)

INFILTRATION RATES FOR URBAN COVERS: Table 10-5

COVER TYPE	QUALITY OF COVER	SOIL GROUP			
		A	B	C	D
Residential or Commercial Landscaping	Good	.48	.25	.16	.12
	Poor	.26	.09	.06	.04
Open Space	Fair	.31	.16	.09	.07
	Good	.41	.22	.12	.09
	Poor	.07	.06	.03	.02
Streets and Roads: Paved with open ditches Gravel, Dirt	Fair	.11	.06	.04	.03
	Good	.14	.08	.05	.04

Most soils within the City of Roseville are of Soil Group D. If the Consulting Engineer feels that the soil group in the area of development is of a different group, he must supply additional information to substantiate his assumption.

Soil Groups: The Soil Conservation Service (SCS) classifies soil into four hydrologic soils groups. Soils maps and soil surveys of the City are available for inspection at the Placer County Resource Conservation District and the Flood Control District.

Group A: Low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B: Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C: Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

Group D: High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

E. Connecting Separately Connected Areas: When both pervious and connected, impervious overland flow areas are present, the estimate of combined flow is computed as a weighted adjustment to the peak unit runoff as follows in Equation 10-5:

$$Q_p = A(qu - pF_i) \text{ [Equation 10-5]}$$

Where:

- Q_p = peak flow(cfs)
- A = total watershed area (acres)
- qu = unit peak unadjusted runoff (cfs/acre)
- F_i = infiltration factor (cfs/acre)
- P = percent of pervious area (%)

F. Procedure: The following procedures shall be used in determination of design runoff:

1. Determine the typical pervious and connected impervious flow paths with the longest response time.
2. Determine the total response time for the shed being analyzed combining the overland flow elements and their common collector.
3. Determine unit peak unadjusted runoff (qu) for the shed area using Equation 10-3.
4. Determine the pervious infiltration factor using Equation 10-4.
5. Complete the total peak flow using Equation 10-5.

EXAMPLE OF UNIT PEAK DISCHARGE METHOD

For this example, the following assumptions were made:

1. Lots have constant slope of one percent.
2. Lots have a Bermuda grass ground cover.
3. Average elevation of subdivision is 200 feet.
4. Class D soils.
5. Area = 65% impervious, 35% pervious.

See Figure 10-1 for a typical lot detail. A sample computation sheet is provided the end of this Section.

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Step 1 Determine overland response time t_{ro} as follows: $t_{ro} = \frac{.355(nL)^{0.6}}{S^{0.3}}$

Overland flow length = 160'
Bermuda grass cover, $n = 0.24$
Slope = 1%

Equation 10-2 gives: $t_{ro} = 12.6$ minutes

Step 2 Determine collector flow, t_{rc} , as follows:

Collector flow to inlet is assumed to be gutter flow. Gutter flow velocity = 2.0 fps.

$t_{rc} = 420 \text{ ft} / 2 \text{ fps} = 3.5$ minutes
Response time $t_r = t_{ro} + t_{rc} = 16.1$ minutes

Step 3 Determine the unit peak discharge for 10-year storm from Equation 10-3

$qu = c_o t_r^{C_1}$ [Equation 10-3]

$t_r = 16.1$ minutes
 $C_o = 5.8$
 $C_1 = -0.50$
 $qu = 1.45$ cfs/acre

Step 4 Determine infiltration factor:

Elevation = 200 feet
Class D soils, residential landscaping with good cover.
Infiltration factor = .12 (Table 10-5)

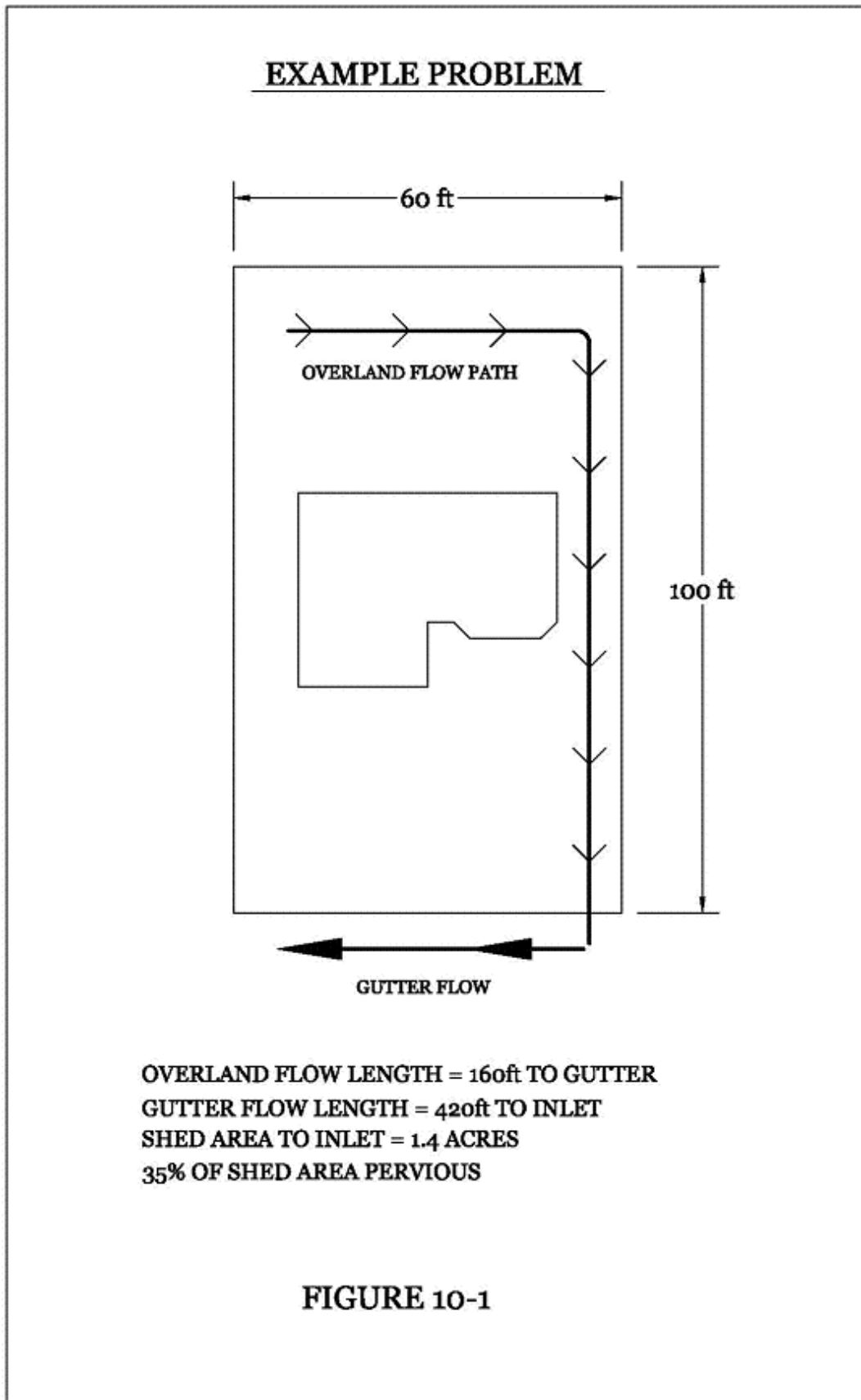
From Equation 10-4, $F_i = 1.7 * I$
 $F_i = 0.21$

Step 5 Compute total peak flow:

Pervious area = $(.035)(1.4) = .49$ acres
 $Q_p = 1.4(1.45) - .49(.21) = 1.93$ cfs

This establishes flow into the drainage system. From this point, the time within the conduit is added to both the impervious response times and conduits are sized appropriately.

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10-10 HYDRAULIC STANDARDS FOR DRAINAGE SYSTEMS

All storm drain pipelines and open channels shall be designed to convey the design peak runoff calculated per Section 10-8 and shall conform to the following requirements:

- A. Hydraulic Grade Line:** The grade line for the 10-year discharge shall be a minimum of one foot below all inlet grates, manhole covers, and all other drainage structures in the system. The hydraulic grade line shall be shown on the plans when it is above the top of the pipe.
- B. Manning's Formula:** The "n" value used in Manning's formula shall conform to the following:
1. Manning's formula shall be used to compute capacities of all open and closed conduits other than culverts.
 2. A minimum "n" value of 0.015 shall be used for sizing conduits.
 3. Minimum velocity in closed conduits shall be 2 feet per second. Maximum velocity shall be 12 feet per second. Velocities shall be based on full flow conditions.

10-11 STREET INUNDATION REQUIREMENTS

City streets are allowed to convey runoff for storm events larger than the 10-year. The standards for street inundation are specified in Table 10-6. The Consulting Engineer shall provide calculations and an exhibit showing that these standards are met. Street inundation calculations will assume the pipe system is fully functional.

ALLOWABLE STREET INUNDATION: Table 10-6

STREET	10-YEAR STORM	25-YEAR STORM	100-YEAR STORM
<p>LOCAL</p> <p>At continuous grade, uphill, and downhill</p> <p>At Sag Points</p>	<p>Traveled lanes remain clear and do not carry storm water.</p> <p>Storm water elevation does not exceed top back of curb or back of sidewalk. Maximum depth in traveled way is 6". Centerline shall be dry</p>	<p>Maximum depth at gutter flow line shall not exceed top-back-of-S/W (if no S/W, or S/W is offset) or a max. of 6". Centerline of street shall remain dry.</p> <p>Storm water elevation does not exceed 4" above the top back of curb. Maximum depth in traveled way – 6".</p>	<p>Maximum depth at gutter flow line shall not exceed 4" above the top –back-of-curb or a max. of 10". Max. depth at centerline is 4"</p> <p>Storm water is a maximum of one foot below building pads. Ponding does not exceed more than 120' from inlet along any street</p>
<p>COLLECTOR</p> <p>At continuous grade, uphill and downhill</p> <p>At Sag Points</p>	<p>Traveled way remains clear and does not carry storm water.</p> <p>Storm water elevation does not exceed top back of curb or sidewalk. Maximum depth in traveled way – 6". Centerline shall be dry.</p>	<p>Maximum depth at gutter flow line shall not exceed top-back-of-curb or max. of 6"</p> <p>Storm water elevation does not exceed 4" above the top back of curb. Maximum depth in traveled way – 6".</p>	<p>Storm water flow is contained within the right-of-way. The center 12 feet of roadway shall remain clear of storm water.</p> <p>Storm water flow is contained within the right-of-way. The center 12' of roadway shall remain clear of storm water.</p> <p>Note: If the roadway is separated by a median, then each half of the roadway shall maintain a 12' clear path of travel.</p>
<p>ARTERIAL & EXPRESSWAY</p> <p>At continuous grade, uphill and downhill, or at sag points</p>			<p>All travel lanes are clear of storm water flow. Bike lanes are allowed to be inundated. Storm flow contained within the right-of-way.</p>

10-12 CLOSED CONDUITS

The specific type of pipe or alternate pipe to be used in any development shall be shown on the approved plans. If the Consulting Engineer proposes to use any type of pipe not shown on the approved plans, the plans shall be resubmitted to the City Engineer for approval.

A. Size and Material: Drainage systems to be maintained by the City shall have a minimum pipe diameter of 12 inches. Private, onsite drainage systems that are reviewed by the City shall have a minimum pipe diameter of 8 inches. The types of pipe materials that are allowed are stated in the City of Roseville's Construction Standards, Section 101-8 D.

B. Cover Requirements: See details DR-19 and TB-2 for minimum pipe cover requirements.

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 Consulting Engineer shall design the pipe structural requirements in accordance with good engineering practice. If trench conditions are uncertain, a note shall be placed on the plans making it the Contractor's responsibility to work with the Consulting Engineer to determine and place the proper strength pipe if poor trench conditions are encountered.

C. Alignment: Pipelines for storm drainage shall have a constant slope between manholes, junction boxes, and/or catch basins. Minimum radius of horizontal curvature shall be 200 feet. In no case shall the radius of curvature be less than the manufacturer's recommendations for the particular pipe size under consideration.

Drainage pipelines shall be located in the street whenever possible. The location of storm drainage pipelines in the streets shall be 5 feet north or west of and parallel with the street centerline. A minimum angle of 90 degrees shall be accommodated for downstream flow around bends, tees, and connection points.

When storm drainage lines are to be placed in existing streets, factors such as curbs, gutters, sidewalks, traffic conditions, pavement conditions, future street improvement plans, and existing utilities shall be considered.

Open ditches, lined channels, swales, and floodplain areas shall be maintained as nearly as possible in their existing alignment. When an open ditch is to be constructed parallel to an existing roadway, the ditch shall be constructed outside the proposed right-of-way of the ultimate street development.

10-13 MANHOLES

Standard precast concrete manholes shall be constructed as required. Where special manholes or junction boxes are required, the City Engineer must accept the design. In no case will junction boxes or manholes be allowed which are smaller than 48 inches inside diameter. Manholes shall be located at junction points, angle points, changes in gradient, changes in conduit size, end of curves and beginning of curves. Manholes or junction boxes will not be required for reach of pipe less than 80 feet in length that is to be connected to a 36 inch or larger diameter pipe, subject to

approval of the City Engineer. For straight alignment, the spacing of manholes shall not exceed 500 feet. The spacing of manholes shall be nearly equal whenever possible. On curved pipe, spacing of manholes shall be as specified in Table 10-7:

MANHOLE SPACING: Table 10-7

RADIUS	PIPE DIAMETER	SPACING
400' OR LESS	ALL	300'
GREATER THAN 400'	24" OR LESS	400'
GREATER THAN 400'	GREATER THAN 24"	500'

- A. Saddle Manholes:** Saddle manholes may be constructed on storm drain conduit 36 inches or greater in diameter provided that no junction exists with any other storm drain conduit as determined by the Director.
- B. Covers:** All manholes and junction boxes, other than inlets, shall have standard manhole covers per the Standard Drawings. No pipe will be allowed to enter a manhole into the transition portion of the manhole cone. Manholes will not be allowed in gutter flow line except where approved by the City Engineer. Slotted manhole covers may be used to pick up minor drainage in non-traffic areas.

10-14 INLETS

Drop inlets in streets shall be located on property lines in residential subdivisions except at intersections, where they shall be placed at curb returns. Inlets shall be such that the length of the flow in the gutter does not exceed 500 feet. The depth of flow in the gutter at the inlet shall not exceed 4.0 inches in a 10-year storm and shall not encroach into the traveled ways as specified in Table 10-6 for other design storms. The runoff volume shall include any flow that bypasses upstream inlets.

All inlets located with the right-of-way or easements shall conform to the City of Roseville's Construction Standards. Inlets may be modified for use without curb sections for on-site drainage. Where an inlet is proposed in public streets and sidewalk is not constructed adjacent to the back of curb, a concrete collar shall be placed behind the inlet. Type C inlets may be used as junction inlets if the flow line is 4 feet or less below the grate elevation.

Drop inlets draining public streets may be connected directly to a trunk line 36 inches in diameter or larger by means of a lateral not exceeding 15 inches in diameter and 80 feet in length.

10-15 JUNCTION BOXES

The requirement for junction boxes are as follows:

- A. Junction boxes** shall be constructed of reinforced concrete or fabricated from reinforced concrete pipe section where size limitations permit. Structural calculations shall be provided for all junction boxes.

- B.** Minimum wall thickness for reinforced concrete junction boxes shall be 6 inches.
- C.** The inside dimension of junction boxes shall be such as to provide a minimum of three inches of clearance on the outside diameter of the largest pipe in each face. All junction boxes shall be rectangular in shape unless otherwise approved by the City Engineer. Junction boxes deeper than 4 feet shall have a minimum inside dimension of 48 inches.

10-16 INLET AND OUTLET STRUCTURES

The requirements for these facilities are as follows:

- A. Headwalls, Wingwalls, and Endwalls:** All headwalls, wingwalls, endwalls, preformed end sections, guard rails and bank protection shall be considered individually and shall be, in general, designed in accordance with the Standard Specifications and Standard Plans of the California Department of Transportation and City of Roseville, Construction Standards.

Metal beam guardrails or chain link fencing may be required by the City Engineer at culverts, headwalls, box culverts, and steep side slopes.

- B. Trash Racks and Access Control Racks:** Trash racks will be provided where they are necessary to prevent clogging of culverts, storm drains, and to eliminate hazards. Access Control Racks shall be required on all pipes, 24 inches or larger in diameter.

10-17 DRAINAGE PUMPS

Drainage pumps shall be avoided whenever possible, and used only with specific approval of the City Engineer. If the use of drainage pumps is permitted, the drainage system shall be designed so as to provide for gravity outfall during the summer months and other periods of low water stages. If a low stage gravity outfall is impossible or impractical, an alternative pump of a smaller capacity for low stage flow may be used provided the City Engineer grants specific approval.

- A. Design Requirements:** Pumping installations shall be designed to accommodate a design storm as specified by the City Engineer. When a station contains a gravity discharge, pumping capacity must be equal to the design inflow. When the station does not have a gravity discharge, pumping units must be designed to furnish 100 percent capacity with any one pump out. Any deviation from this criteria must receive the specific approval of the City Engineer.

Pumping stations shall be designed so that gravity flow does not pass through the pump pit. No motor overload condition shall exist at any sump or flow condition. This does not preclude high sump design if low sump condition does not create an overload.

Each pumping station shall receive separate approval for the electrical system, piping system, housing installation and other miscellaneous design features. The electrical system for

drainage pumps shall conform to the electrical code and the State Department of Transportation Standards.

A detailed Operation and Maintenance Plan (O&M Plan) shall be submitted to the Engineering Division for approval prior to the approval of the pumping station.

- B. Maintenance Requirements:** Adequate access shall be provided for cleaning the pump sump. Trash racks shall be provided upstream from the pumping plant. Provisions shall be made for easy cleaning of the trash racks. Hatch covers, where used, shall be of raised pattern aluminum floor plate, or other approved lightweight cover. Dissimilar metals shall be insulated from each other when necessary. Ladder rungs, where used, shall be of non-slip variety. All drainage pumping plant sites shall be fenced with 6-foot chain link fence with barbed wire extensions arms.

10-18 CHANNELS AND OUTFALL DESIGN

Drainage shall be conveyed in an open channel if the drainage area exceeds 300 acres. Residential lots adjacent to open channels shall have minimum pad elevations of two feet above the 100-year water surface elevation. Non-residential lots shall have the lowest ground elevation adjacent to the building foundation at least two feet above the 100-year water surface elevation.

- A. Open Channel Design Requirements:** Channels shall be constructed to a typical cross section. Fully lined channels shall be designed with side slopes of 1:1 or flatter. Channels with unlined sides shall be designed with side slopes of 3:1 or flatter, or as specified by the Geotechnical Engineer based on existing soil conditions. Lined channels shall have a minimum bottom width of 6 feet. Lined channels shall be finished concrete, sacked concrete, or doweled and sacked concrete. The minimum weight of sacked concrete shall be 60 pounds per bag. Unlined channels shall be designed with a minimum “n” value of 0.085.

All open channels shall be designed to carry the 100-year frequency design storm. The hydraulic grade line of the 10 and 100-year storms shall be calculated and plotted on all channel profiles. Freeboard shall be a minimum of one foot for the 100-year event and two feet when the drainage area exceeds 300 acres. The velocity range shall be 2.5 to 6.0 feet per second in unlined open channels and 3.0 to 12.0 feet per second in lined open channels. All computations shall be clearly documented and submitted to the City Engineer for approval.

For all channels, either realigned or natural, the following shall be shown on the improvement plans in addition to the information heretofore required:

1. The profile of existing channels shall be shown for a minimum of 1000 feet at each end of the development on the construction plan to establish a minimum profile grade.
2. Typical sections and cross sections.

B. Interceptor Ditches: Interceptor ditches or approved alternates shall be placed at the top of the cut or bank where deemed necessary by the City Engineer to prevent erosion of the channel bank. Runoff shall not be allowed to sheet flow over the top of banks.

C. Outfall Profiles: All drainage outfalls shall be shown both in the plan and profile view, on the improvement plans for a distance of 1000 feet or until a definite “daylight” condition is established. All drainage ditches upstream of the improvement shall be shown on the plan and profile sheets for a distance of at least 500 feet or until an average profile grade through the improvement is established. The profiles shall include ditch flow line and top of bank elevations.

When improvements have more than one unit, 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. All temporary outfalls shall be shown both in plan and profile view, on the improvement plans.

D. Fencing: Channels exceeding three (3) feet in depth and with side slopes steeper than 3:1 shall be fenced with six(6) foot high chain link fence per Section 80-4 of the Caltrans Standard Specifications. In all other areas, fencing shall be placed as specified the City Engineer. Fences shall be located 6 inches inside the drainage easement lines and a minimum of 12 inches from the top bank. No fencing shall be allowed within the floodway of an open watercourse without the approval of the City Engineer. Special requirements shall be specified by the City Engineer for fencing within the 100-year floodplain of any open watercourse.

Drive gates shall be provided with a minimum width of 12 feet. A minimum 4-foot wide walk gate shall also be provided.

E. Access Roads: An all-weather access road consisting of six (6) inches of compacted AB shall be provided adjacent to all channels and outfall ditches to the satisfaction of the City Engineer. Access roads shall have a minimum width of 12 feet and shall provide a bulb at end for turning movements.

10-19 CROSS CULVERTS AND BRIDGES

This section specifies criteria for relatively short circular or box culverts and bridges for transverse crossings (typically road or railroad embankments). Cross culverts shall be of the same material as allowed for closed conduits. (See Section 10-11).

Cross culvert profiles will be determined on an examination of the channel for a minimum distance of 1000 feet on each side of the installation.

Driveway culverts shall be approved by the City for size, grade, alignment and type. Driveway culverts will not be allowed unless the City has agreed to deter the construction of the curb and gutter unless it is for the temporary construction access.

New culverts or bridges for roadways that cross the City's Regulatory Floodplain shall incorporate provisions for the installation of permanent stream measuring equipment. This shall be a 10' x 10' flat pad near the 100-year water surface elevation with vehicle access. A two(2) inch diameter electrical conduit from the pad to the flow line of the channel will be installed, (see detail DR-21 of the City of Roseville Construction Standards).

A. Design Storm: Cross culvert size shall be determined on the basis of runoff as specified in the hydrology portion of this section. Cross culverts, in general, shall be designed for a 25-year storm event with no head on the inlets. They shall also be sized such that no serious damage will be incurred due to ponding as a result of a 100-year event. A flood easement shall be provided for all areas impacted due to upstream ponding in the 100-year event. Culverts across arterials shall be sized for the 100 year storm with a minimum of one foot of freeboard below the lowest travel lane. Minimum diameter of cross culverts shall be 18 inches.

To account for debris collection, a clogging factor of 150% shall be applied to all storm frequencies in the design of bridges or culverts that cross a channel or stream with a drainage area that exceeds 300 acres.

Note: New bridges along planned bike trail corridors need to be designed so that the head clearance on the trail will meet the standards of Section 13-5.

B. Computation of Flow: Inlet or outlet conditions control flow in transverse culverts. In culverts operating under inlet control, the cross-section area of the culvert barrel, the inlet geometry and the amount of headwater at the entrance are primary importance. Outlet control involves the additional consideration of the elevation of the tail water in the outlet channel and the slope, roughness and length of the culvert barrel.

Anticipated downstream flow depth and allowable headwater depth govern the available head on culverts. The type of flow under which a culvert will operate may be determined from a given set of conditions. This may be avoided by computing headwater depths from the charts in this section for both inlet and outlet control and then using the higher value to indicate the type of control and to determine the headwater depth. This method of determining the type of control is accurate except for a few cases where the headwater depth is approximately the same for the both types of control. The monographs provided in this section shall be used for culvert design with uniform barrels. Where barrel sizes or entrance configurations differ between barrels, written calculations shall be provided to the satisfaction of the City Engineer.

The roughness coefficient, "n", can be adjusted for the monographs by use of the following equation:

$$L_1 = L * \left[\frac{n_1}{n} \right]^2$$

10-20 DETENTION AND RETENTION BASINS

If detention or retention basins are required for peak flow reduction, the design of the basin must conform to the latest addition of the Placer County Flood Control District's "Stormwater Management Manual". The basin layout and design shall minimize its maintenance time and cost. The basin should be designed to allow for the 2-year storm event flows to bypass the basin. This will be key factor in the approval of the basin's O&M Plan by the Engineering Division.

10-21 ACCESS FOR MAINTENANCE

These facilities may include, but are not limited to bridges, culverts, headwalls, lined and unlined channels/ditches, sand/oil separators, manholes, retention basins and drain inlets. The access way shall be a minimum 12 feet wide and include six(6) inches of ¾ inch aggregate base (95% relative compaction) over six(6) inches of processed, native soil (95% RC). Upon the City Engineer's request, four (4) inches of asphalt concrete shall be added to the section and/or a cul-de-sac with a minimum diameter of 75 feet.

STANDARD HYDRAULIC CALCULATIONS SHEET

TO	FROM	AREA	CUMU. AREA	T _r	q	F _i	Q _p	STORM DRAIN PIPE						HYD GRADE LINE						
								DIA	SL	L	Q _{max}	VEL	T _c	SL	UMH	LMH				

January 2023

CITY OF ROSEVILLE – ENGINEERING DIVISION

SUBMITTAL REQUIREMENTS FOR ALL

HEC – 1 STUDIES

Submit the items listed under each category that applies to each HEC – 1 model run that is submitted.

1. Hec-1 print out with summary tables.

The following information shall be on the cover of the print out:

- Name of engineering firm who performed the study
- Name of the project
- Version of HEC-1 program
- Date & time that the model was run
- A statement if the model is pre-project or post-project

2. The computer model disk.

- Disk must be clearly labeled
- If more than one model file is on the disk, a listing and description of all files shall be included with the disk in an envelope
- HEC-1, HEC-2 or HEC-RAS files shall be submitted on separate disks

3. City of Roseville’s “Model Summary Worksheet” Pages 1-3 completed out for each HEC-1 run submitted and attached to the printout.

4. Drainage Shed map showing the following:

- Outline of all subsheds used in the HEC-1 study
- The label of each subshed as modeled in the HEC-1 study
- The area of each subshed as used in the HEC-1 study
- The location where each subshed merges with the next clearly marked

5. If the study compares pre-project to post-project HEC-1 models, the City’s summary sheets shall include a listing of all the types and the locations of changes made in the model

**CITY OF ROSEVILLE
HEC -1 MODEL SUMMARY WORKSHEET
GENERAL INFORMATION**

Name of project: _____

Name of engineering firm who performed the study: _____

Contact person _____ Ph# _____

If this replaces a previously submitted study, what is the name of that study?

This study reflects: Existing conditions Post-development conditions

If this HEC-1 study is used to compare pre-project to post-project runoff, what is the name of the study that you are comparing it with? _____ Run date _____

Has the pre-project study been approved by the city? **YES** and when _____
 NO

BASIN INFORMATION

Total area of the basin studied (sq. mile) _____ Number of sub-sheds _____

Elevation of shed: High point _____ Low point _____ Ave. _____ Used _____

The method used to determine the design storm used in the model:

- P.C. Flood Dist. manual HEC-1 synthetic storm
- P.C. Flood Dist. PDP program Rain gauge data

Duration of design storm: 1 hr 2 hrs 3 hrs 6 hrs 12 hrs 1 day other _____

Design storm frequency: 2 yr 5 yr 10 yr 25 yr 50 yr 100 yr other _____

Base flow (cfs / sq mile): _____ Infiltration (in/hour) _____

Response time of entire basin _____

Detention Basins Give location and size of all detention basins that were modeled:

Provide topo or grading plans used to calculate storage volume for each detention basin.

Location in model	Amount of storage resulting from each design storm	Storm frequency	Max. Stage Height (ft.)	Freeboard to Spill Point (ft.)
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

CITY OF ROSEVILLE
HEC-1 MODEL SUMMARY WORKSHEET

SUBSHED INFORMATION

The total number of subsheds in the model: _____

Provide an assumed "N" factor used most often for the following surfaces:

Overland swales _____ Concrete gutters _____ Drainage Pipes _____

Earth-lined channels _____ Streams _____ Other _____

TITLE OF SUBSHED OR ROUTING LEG IN MODEL	PRIMARY LAND USES OF SUBSHED residential, open space, commercial, etc.	AREA OF SUBSHED (SQ ML)	METHOD USED IN ROUTING EXAMPLE: Kinematic wave, Muskingum	WAS DETENTION MODELED (YES OR NO)

**CITY OF ROSEVILLE
HEC-1 MODEL SUMMARY WORKSHEET**

PRE-PROJECT TO POST-PROJECT CHANGES

This sheet shall be completed if this HEC-1 study is used to compare pre-project to post-project runoff.

Name of pre-project HEC-1 study : _____

Run date _____

Basin's peak flow rate: Existing conditions _____

Post-development conditions _____

Has the pre-project study been approved by the City? _____ **YES** If yes, when? _____
 _____ **NO**

Locations in	Types of change made
Example Shed-2S	Change earth-lined channels to drainage pipes and increased sub-shed area

January 2023

**CITY OF ROSEVILLE - ENGINEERING DIVISION
SUBMITTAL REQUIREMENTS FOR ALL
HEC-2 or HEC-RAS STUDIES**

SUBMIT THE ITEMS LISTED UNDER EACH CATEGORY THAT APPLY TO EACH **HEC-2 or HEC-RAS** MODEL RUN THAT IS SUBMITTED.

1. HEC-2 or HEC-RAS print out with summary tables.
The following information shall be on cover of the print out:
Name of engineering firm who performed the study
 - Name of project
 - Version of HEC-2 or RAS program
 - Date & time that the study was run
 - Statement if the study is pre-project or post-project and, if applicable, if the study is a Duplicate Effective Model, Corrected Effective Model, Existing or Pre-Project Conditions Model, and/or Revised or Post-Project Conditions Model
2. Provide the computer model on a new USB flash drive (Sandisk, PNY, or Kingston) or CD/DVD disk.
Flash Drive/Disk must be clearly labeled.
 - If more than one model file is on the flash Drive/disk, a listing and description of all files shall be included with the flash Drive/disk in an envelope.
 - HEC-1, HEC-2 or HEC-RAS files needs to be submitted in separate folders within flash drive/disk(s).
3. City of Roseville's "Model Summary Worksheet" pages 1-3 filled out for each HEC-2 or HEC-RAS run that is submitted
4. Water course map showing the following:
 - Lay out of the route of all water courses used in the HEC-2/RAS study.
 - All man-made structures with their type and size will be clearly marked and labeled (bridges, culverts, storm drain pipes, man-made channels, etc.).
 - Map of the locations and number of all cross-section used in study.
 - The starting HGL and peak flow rate for all storm frequencies modeled.
 - The location of where the flow rate changes and what the new flow rate is.
5. If the study compares pre-project to post-project HEC-2/RAS models, you shall include a summary sheet listing the locations and types of changes made between the models.

CITY OF ROSEVILLE
HEC-2 / HEC-RAS MODEL SUMMARY WORKSHEET

Name of project: _____

Name of engineering firm who performed the study: _____

Contact person _____ Phone # _____

If this replaces a previous study, what is the name of that study _____

This study reflects: Existing conditions Post-development conditions

If this HEC-2/RAS study is used to compare pre-project to post-project runoff what is the name of the study that you are comparing it with _____ Run date _____

Has the pre-project study been approved by the city yes no

If yes, name and when

Total length of water course (miles) _____ Total number of cross-sections _____

Name of Hydrology study used to get peak Discharge? _____

Design storm frequency: 2 yr 5 yr 10 yr 25 yr 50 yr 100 yr Other _____

The starting HGL _____

Starting flow rate _____

How was the starting HGL determined:

Give location of cross-sections where the flow rate changes and what the new flow rate(s) are.

START	10 YEAR	50 YEAR	100 YEAR

CITY OF ROSEVILLE
HEC-2 / HEC-RAS MODEL SUMMARY WORKSHEET

CHANNEL REACH INFORMATION

Give the total number of reaches in the Model _____

Provide assumed "N" factors used most often for the following surfaces:

Overland swales _____ Concrete Gutters _____ Drainage Pipes _____

Earth-lined channels _____ Streams Channel _____ Main channel _____

Over Bank _____ other _____

Are the assumption used in hydrology study's routing section to determine peak discharge, in line with those used in this hydraulic study for the same segment of channel (channel length, "N" factor, etc.) **yes** **no** If **no** explain why _____

BRIDGE OR CULVERT MODEL INFORMATION

Provide the following Information for all Bridge and Culvert crossings:

DOWN STREAM X-SEC. AT BRIDGE OR CULVERT	METHOD USED TO MODEL (special culvert, bridge, etc.)	IS STRUCTURE OVERTOPED example (2.1' in 50 yr, 3.4' in 100 yr)	WAS DETENTION MODELED (YES OR NO)

January 2023

HEC-2 / HEC-RAS MODEL SUMMARY WORKSHEET

PRE-PROJECT TO POST-PROJECT CHANGES

Name of pre-project study: _____

Run date _____

Name of post-project study: _____

Run date _____

Do you plan to place any improvements in, or change the Floodway **yes** **no**

If **yes**, explain.

Provide the following Information for all changes between studies:

Location	Types of changes (added, deleted, changed)
Xsec-252	Added xsec. to reflect encroachment, changed right overbank "N" to 0.04

January 2023

Floodplain Encroachment Compliance Statements

Improvements are being proposed within the 100-year floodplain of the City of Roseville.

These improvements are shown on the plans for:

The proposed plans for: _____

Designed by: _____

Dated: _____

A hydraulic study has been completed to show the hydraulic impacts of all of the improvements proposed within the floodplain shown on these plans. The title of this study is:

Title of hydraulic study: _____

Prepared by: _____

Dated: _____

I certify that I have looked at both the plans and the study and found that the improvements that are within the 100-year floodplain shown on the plans listed above are in conformance with the hydraulic study listed above and are accurately represented in the study.

Signed

R.C.E Lic. Number _____ Expires _____