City of Rohnert Park

Storm Drain Design Standards

Design Standards
for Public Improvements

Volume 1
Revised February 2014

STORM DRAIN DESIGN STANDARDS
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Volume 1

Design Standards

Storm Drain Standards

ENGINEER'S LIST OF APPROVED ITEMS
for use with Storm Drain Design Standards
Approved __________ **Date** 7/14/14

Standard 400 – Standard Precast Concrete Storm Drain Manhole

Central Precast Products Drawing No. 20-48C, 20-48E, and 20-60EC
KriStar Enterprises, Inc., Model No. DD-48 & DD-60 series bases, riser and cones

Standard 401 – Precast Concrete Storm Drain Manhole Reducer Slabs

Central Precast Products Drawing NO. 20-48ERS, 20-60ERS, and 20-60CRS
KriStar Enterprises, Inc., Model No.DD-48 & DD-60 series slab reducers

Standard 402 and 405 – Type II Catch Basin

Central Precast Products Model NO. 4A and 3L
KriStar Enterprises, Inc., Model No. P2448CI & DD-P2448B

Standard 403 – Type I Catch Basin *(Note: Approval by variance required)*

Central Precast Products Model No. 3K base and 3K frame and grate (H2O, bicycle proof)
Central Precast Products Model A2 or A4

Standard 404 – Storm Drain Gallery

Central Precast Products Model 6Y and 12Y

Standard 406B – 3" x 12 ½" Sidewalk Drain

Alhambra Foundry Model A-470 size - 3" x 12 ½"

Standard 408 – Side Opening Drop Inlet

Central Precast Products Drawing NO. DI-SO (model 2K or larger) H20 rated with side openings and ¼" galvanized checker-plate cover
KriStar Enterprises, Inc., P24 or larger drop inlets with side openings and ¼" galvanized check-plate cover.

Standard 409 – "No Dumping" Label

Almetek's MET AL Storm Drain Markers SDS4R0331BLNAH; blue, stainless steel, all copy embossed, square punched center hole

PREFACE

Quick Reference Sheets

These standards have been prepared to assist developers and their engineers in the design of public storm drain facilities. To assist those engineers who are familiar with these standards, quick reference sheets are provided in this Preface section. The quick reference sheets contain design criteria and data from the standards which are most commonly used in the design of public storm drain facilities. Unless otherwise noted, hydrological and hydraulic standards are consistent with the Sonoma County Water Agency Flood Control Design Criteria Manual, Revised August 1983.

Quick reference sheets are provided for the following subjects:

1. Hydrology
2. Hydraulics
3. Design Requirements

QUICK REFERENCE SHEET
HYDROLOGY

Waterway Classification	*Drainage Area, Square Miles*	*Recurrence Interval, Years*
Major	34	100
Secondary	1–4	25
Minor	>1	10
Diversion	Not applicable	100

Q = CIAK

where:

Q = flow (cubic feet per second)
C = runoff coefficient
I = rainfall intensity
A = drainage area (acres)
K = mean seasonal precipitation = 1.1 for small Rohnert Park drainage areas. For large drainage areas, minor and above, see Sonoma County Water Agency Standards.

Initial Time of Concentration (Tc)

Land use	***Tc***
Commercial/industrial/residential with more than 8 units per acre	7 minutes
Residential, 2 to 8 units per acre	10 minutes
Residential, less than 2 units per acre	15 minutes
Open Space	15 minutes

QUICK REFERENCE SHEET
HYDRAULICS

Design Waterway Classification	*Downstream Waterway Classification*	*Design Flow in Downstream Waterway, Years*
Secondary	Major	25
Minor	Major or secondary	10
Surface (ground)	Major or secondary	100
Diversion	Not applicable	100

Manning's formula

$$Q = \frac{1.49}{n}(A)(R^{2/3})(S^{1/2})$$

Manning's formula coefficient (n)

Material	*Manning's "n"*
Storm drain pipe [high density polyethylene pipe (HDPE) and reinforced concrete pipe (RCP)]	0.014
Concrete-lined channel	
Asphaltic concrete	0.015
Grouted rock rip rap	0.017
Loose rock rip rap	0.030
Grass-lined channel	0.035
Constructed natural waterway	0.035 minimum
	0.050 minimum

Minimum design flow velocity = 2.5 feet per second

Waterway Classification	*Waterway Type*	*Minimum Freeboard*
All	Open channel	1.5 feet or 20 percent of specific energy (whichever is greater)
Major and secondary	Closed conduit	0.2 x diameter
Minor	Closed conduit	1 foot below top of curb or adjacent ground surface
Gutter	Open channel with 6-inch curb	0.4 feet maximum depth

QUICK REFERENCE SHEET
DESIGN REQUIREMENTS

Minimum pipe diameter:	15 inches	
Pipe materials:	Reinforced concrete pipe (RCP) or high-density polyethylene (HDPE) pipe that conforms to these specifications; use of cast-in-place concrete is not allowed	
Horizontal separation from sewer lines:		5 feet clear
Horizontal separation from water lines and other utilities:		4 feet clear
Vertical curves:	Not allowed	
Horizontal curves:	RCP:	300 feet minimum radius (allowed at catch basins and when pipeline is installed under the pavement parallel to the concrete gutter)
	HDPE:	765 feet minimum radius for 20 foot sections
Pipe slope:	10% maximum	
Minimum cover:	12 inches for class III RCP and HDPE (outside of pipe to road subgrade).	
Maximum distance between structures:	400 feet	

New development and redevelopment projects may be required to implement storm water quality source and treatment controls. Refer to the City of Santa Rosa and County of Sonoma Storm Water Low Impact Development Technical Design Manual for design criteria; available at the following link,
http://ci.santa-rosa.ca.us/departments/utilities/stormwatercreeks/swpermit/Pages/swLIDtechManual.aspx

STORM DRAIN DESIGN STANDARDS

I. GENERAL AND DESIGN CRITERIA

All design shall conform to Sonoma County Water Agency design standards and review process.

All storm drainage facilities constructed within the City of Rohnert Park shall comply with the Sonoma County Water Agency master plan.

There shall be no lot-to-lot drainage.

II. PURPOSE

The purpose of this document is to provide standards for design of public storm drain system improvements in the City of Rohnert Park (City). These standards consist of:

(1) Hydrologic design criteria,
(2) Hydraulic design criteria, and
(3) Physical design requirements.

These standards do not include (but may reference) additional requirements established by other departments of the City and other government agencies. These standards are intended to impose **minimum** acceptable design criteria. More stringent requirements may be imposed by the City Engineer based on specific project conditions. Developers and their design engineers are responsible for complying with these standards and all other requirements for design of storm drain facilities within the City. Design engineers are responsible for initiating written requests for approval of any design concepts that differ from these standards, verifying additional requirements set forth by other departments of the City or other government agencies, performing any necessary calculations or studies, and resolving any problems with the appropriate department or agency. Developers and design engineers should be aware that Section 402(p) of the federal Clean Water Act establishes requirements for National Pollutant Discharge Elimination System permits for certain industrial and construction-related storm water discharges.

III. POLICY

The policy of the City is to safely collect and convey storm water to the nearest public flood control facility in a storm drain system approved by the City of Rohnert Park Engineering Department, while achieving water quality objectives to the maximum extent practicable in the City's creeks as defined in the City's Storm Water Management Plan.

IV. HYDROLOGY CONCEPTS

The Rational Method is widely used for determining design flows in urban and small watersheds. The method assumes that the maximum rate of runoff for a given rainfall intensity occurs when the duration of the storm is such that all parts of the watershed are contributing to the runoff at the interception point. The formula used is an empirical equation that relates the quantity of runoff from a given area to the total rainfall falling at a uniform rate on the same area and is expressed as:

$$Q = CIAK$$

in which

Q is the design flow in cubic feet per second.

C is a dimensionless runoff coefficient based upon type of ultimate development (i.e., land use) from Table I-1 for the drainage area.

I is the intensity of rainfall in inches per hour from Figure I-1 or computed as:

$$I = 5.12\ Y^{0.1469}\ t^{-0.528}$$

in which

Y = recurrence interval (10, 25 or 100 year, etc.)

t = time of concentration (duration in minutes)

A is the tributary drainage area in acres.

K is the dimensionless ratio of the average annual rainfall for the drainage area to the average annual rainfall for the overall area for which the rainfall intensity/duration/recurrence interval relationships have been established.

K = 1.1 for small Rohnert Park drainage areas. For large drainage areas, minor and above, see Sonoma County Water Agency Standards.

The runoff coefficient (C), the drainage area (A), and the average annual rainfall ratio (K) are all constant for a given area at a given time. (Note that some agencies do not include the factor K when using the Rational Method.) Rainfall intensity (I), however, is determined by using an appropriate storm frequency (i.e., recurrence interval) and duration which are selected on the basis of economics and engineering judgment. Storm drains are designed on the basis that they will flow nearly full during the design storms. Storm frequency is selected through consideration of the size of drainage area, probable flooding, possible flood damage, and anticipated future development for the drainage area.

Runoff Coefficient. The runoff coefficient (C) normally ranges between 0.30 and 0.90. The soil characteristics, such as porosity, permeability, and whether or not it is saturated from preceding storms are important considerations. Another factor to consider is ground cover, i.e., whether the area is paved, grassy or wooded. In certain areas, the coefficient depends upon the slope of the terrain. Duration of rainfall and shape of area are also important factors in special instances. Of primary importance is the percent of land covered with impervious surfaces such as asphalt.

Rainfall Intensity. Rainfall intensity (I) is the amount of rainfall measured in inches per hour that would be expected to occur during a storm of a certain duration. The storm frequency is the time in years in which a certain storm would be expected again and is determined statistically from available rainfall data. (See Figure I-1.)

Time of Concentration. The time of concentration at any point in a storm drain segment is the time required for runoff from the most hydraulically remote portion of the drainage area to reach that point. The most hydraulically remote portion provides the longest time of concentration but is not necessarily the most distant point in the drainage area. Since a basic assumption of the Rational Method is that all portions of the area are contributing runoff, the time of concentration is used as the storm duration in calculating the intensity. The time of concentration consists of the initial time of concentration, which depends on the anticipated future land use for the drainage area, plus the sum of the additional overland flow time, if any, and the times of travel in street gutters, roadside swales, storm drains, drainage channels, and other drainageways. The time of concentration is affected by the rainfall intensity, topography, and ground conditions.

V. HYDROLOGIC DESIGN

Hydrologic design shall be based on the ultimate development and slope of the tributary watershed. All storm drain facilities shall be designed for flows resulting from 100 percent build-out of the land uses designated in the latest adopted edition of the City's General Plan in effect at the time the proposed development is approved by the appropriate City approval body. Drainage boundaries and basin slope shall be determined from the most current topographic information available. In flat areas, drainage basin boundaries shall be verified with those for other adjacent developments to eliminate gaps or overlaps and maintain consistency. Only areas which do not flow towards the proposed development may be excluded. The design must demonstrate that the excluded areas do not flow into the proposed development.

Flows from tributary areas upstream of the proposed development shall be included in the hydrologic design for the proposed development. The hydrology for the proposed project will be based on a pattern of upstream development which delivers the ultimate development storm runoff to the proposed project. Upstream area flows shall be based on 100 percent build-out of the land uses designated in the latest adopted edition of the City's General Plan in effect at the time the project is designed. Rezoning often results in significantly higher densities than were used in design calculations for existing downstream storm drain facilities. The design of the storm drain system for the proposed development shall be based on the assumption that storm flows from upstream areas will be conveyed in conduits, thereby resulting in lower times of concentration than for undeveloped conditions. The design of the storm drain facilities for the proposed development shall be such that the design flow from the proposed development and the upstream areas is less than or equal to the hydraulic capacity of the downstream storm drain facilities unless otherwise approved. In cases where the design flow exceeds the hydraulic capacity of the downstream storm drain facilities, improvements to the downstream facilities may be required as part of the development.

Developed public areas, including but not limited to public parks and golf courses, may be considered to be vegetated to the extent that they are actually vegetated, unless publicly proposed plans indicate that the governing body having jurisdiction over the area intends to alter the existing use of the area so as to make the surface less pervious. The developer shall confirm future plans for park lands with the City Planning Department.

Drainage systems shall be designed to accommodate flows from storms with specific recurrence intervals. Recurrence interval is defined as the average number of years, over a long period of time, in which the magnitude of discharge from a given flood event is equaled or exceeded. Flows to be used for the design of waterways shall be calculated using the following minimum recurrence intervals:

Waterway Classification	***Drainage Area, Square Miles***	***Recurrence Interval for Design Flow, Years***
Major	>4	100
Secondary	1–4	25
Minor	<1	10
Diversion	NA	100

A given waterway, therefore, will be classed as minor in its upper reaches, then change to the secondary classification at a point where the drainage area exceeds 1 square mile, and then change again to the major classification at a point where the drainage area exceeds 4 square miles.

Design flow shall be determined by the use of the Rational Method formula: Q = CIAK

To use Figure I-1, determine the proper duration of the design storm event. The proper duration is equal to the time of concentration, which is the time required for flow from the most distant location in a drainage basin to reach the point of discharge from the basin.

Drainage areas larger than 2 acres are too large for application of the Rational Method formula in an initial step. The designer shall compute the time of concentration by determining the initial time of concentration. This is the time of concentration at the basin(s) which is furthest upstream. It is based on land use according to the table below. The Rational Method formula shall be applied to each subarea, step by step, and the flow shall be hydraulically routed from subbasin to subbasin to properly accumulate the design discharge for the entire watershed. For further details and sample calculations, refer to the latest edition of the SCWA Flood Control Design Criteria Manual.

Land use	***Initial time of concentration*, minutes***
Commercial, industrial, and residential with more than eight units per acre	7
Residential, two to eight units per acre	10
Residential, less than two units per acre	15
Open Space	15

*initial basins shall be of two acres or less

VI. HYDRAULIC DESIGN CRITERIA

General. For hydraulic design for commonly encountered situations, refer to the latest edition of SCWA Flood Control Design Criteria Manual and supplemental information. For hydraulic design for situations not covered by the SCWA manual, the design engineer shall provide specific references, model study reports, or prototype test results, as necessary to confirm the hydraulic design. Design engineers shall submit design calculations for all public storm drain facilities. As a minimum, the submittal shall include the items shown on the checklist in SD24. Examples of acceptable calculations are included in the appendix to the SCWA Flood Control Design Criteria.

Secondary waterways discharging into major downstream waterways shall be designed to operate while discharging into a 25-year flow in the major downstream waterways. Minor waterways discharging into secondary downstream waterways shall be designed to operate while discharging into a 10-year flow in the secondary downstream waterways. In such cases, the ground elevation along the secondary or minor system shall be above the 100-year water surface elevation in the major or secondary downstream waterway.

If a closed conduit (i.e., pipe or culvert) is used as a secondary or minor waterway, sufficient additional surface routes for flood flows shall be made available to carry the added flow increment up to the 100-year design flow with no more than nuisance damage to improvements or proposed improvements and with no flooding of finished floor of present and proposed future buildings. If such surface routes cannot be made available, the secondary or minor conduit shall be designed to carry the 100-year design flow.

The Manning equation shall be used for hydraulic design of storm drain facilities. The Manning equation is stated as follows:

$$Q = \frac{1.49}{n}(A)(R^{2/3})(S^{1/2})$$

where

Q = flow in cubic feet per second

A = cross-sectional area of flow in square feet

R = hydraulic radius in feet

S = slope of the pipe or channel (dimensionless)

n = Manning equation roughness coefficient (dimensionless)

The values of the Manning equation roughness coefficient "n" shall be as follows:

Material	*n*
Storm Drain Pipe Smooth walled high density polyethylene, or reinforced concrete	0.014
Concrete-lined channel	0.015
Asphaltic concrete	0.017
Sack concrete and grouted rock rip rap	0.030
Loose rock rip rap	0.035
Grass-lined channels	0.035 minimum
Constructed natural waterways	0.050 minimum

For materials other than those stated above, "n" values shall be those presented in the latest edition of the *Handbook of Hydraulics* by King and Brater. The use of n= 0.012 may be allowed for smooth walled high density polyethylene pipe (HDPE) design purposes when the construction drawings clearly indicate the pipe material shall be HDPE and there is no suitable substitute.

Storm drains shall be designed for a minimum velocity of 2.5 feet per second at design flow rates unless otherwise specifically authorized by the City Engineer.

Open Channels. The maximum allowable depth for flows with 10-year recurrence interval in gutters is 0.4 feet. Valley gutters are unacceptable across through streets. Valley gutters may be authorized for use in alleys on a case-by-case basis.

The use of berms, levees, or other facilities along the channel that create potential hydraulic gradelines higher than abutting lands are unacceptable unless specifically authorized by the City Engineer. This requirement is intended to prevent the need for storm water pump stations.

Open channels shall be designed to SCWA design criteria standards with minimum freeboard between design water surface and the top of bank of 1.5 feet or 20 percent of the specific energy, whichever is greater. Where this minimum freeboard does not provide the necessary differential head to allow gravity flow for the projected development of the tributary areas, the design water surface shall be lowered sufficiently to allow such areas to drain by gravity.

Roadside ditches shall be designed so that the water surface for the design discharge will be at or below the outside edge of the road shoulder such that there is no flood water in the normal travel-way of the road and below adjacent ground level.

The design flow in natural creeks and constructed natural waterways may be allowed to overflow into an area above the defined banks provided that the flow is contained within a defined overflow area. Freeboard shall be provided, as specified above, between the design water surface and the adjacent ground surface or finished grade of lots or areas on which improvements are to be constructed. Less than 1.5 feet of freeboard may be considered for small natural swales and creeks through open space such as parks and golf courses. In any event, sufficient freeboard shall be provided to retain the 100-year design flow within the right-of-way of the channel.

Channels shall be designed taking into account the energy losses due to existing and proposed future road crossing structures or other obstructions within the channel. Refer to the latest edition of the SCWA Flood Control Design Criteria Manual for required allowances and other design considerations for obstructions within open channels.

Bridges, culverts and utility crossings which span major and secondary open channels and which are existing, planned or projected at the time of channel design shall have a minimum clearance from soffit to design water surface of 1.0 foot and shall cause no encroachment on the specified minimum freeboard in the upstream channel or waterway.

Constructed natural waterways shall be excavated as required to pass the design flow through interim and ultimate conditions of natural plant and tree growth and of other natural channel characteristics. Trees and other plants and grasses shown on the proposed development plans shall be planted as a part of initial construction to promote and encourage ultimate natural appearance.

Constructed natural waterways, in their final development and growth stages, shall satisfy the freeboard requirements for open channels described above. Constructed natural waterways are appropriate in any situation where right-of-way space can be provided.

Open channels which will be maintained by the SCWA must be designed as specified in the SCWA Flood Control Design Criteria Manual.

Closed Conduits. The design depth in circular conduits shall not exceed 0.80 of the diameter of the conduit for major and secondary waterways. Closed conduits used as minor waterways may be designed to flow full or surcharged. The hydraulic entrance condition at a closed conduit used as a minor waterway will be designed so that the required freeboard in the upstream channel is provided for the 10-year design flow and the 100-year design flow is contained within the banks of the upstream channel. The entrance to the closed conduit may be submerged provided the above criteria are satisfied.

At inlets, catch basins, and nonpressure-type manholes within a closed conduit system, the design flow hydraulic gradeline shall be at least 1.0 foot below the top of curb or of adjacent ground surface if the area is unpaved unless otherwise approved. At locations where conduits are stubbed out for future extension, the design hydraulic gradeline shall be low enough to allow proper drainage of the future tributary area and shall be a minimum of 1.5 feet below general existing ground level unless otherwise approved. For closed conduits designed for supercritical flow, the energy gradeline shall not be above ground level at inlets, catch basins, and nonpressure-type manholes. Where the energy grade line is above the existing ground elevation bolt down manhole covers shall be used.

Energy losses due to debris load caused by splitting flow at the entrance to or within a closed conduit system shall be computed in the same manner as obstruction losses in open channels. In addition to normal friction losses, energy losses due to entrance and exit conditions, bends, and transitions shall be computed and considered.

VII. DETENTION BASINS

The following section on detention basins is not included in the Sonoma County Water Agency Flood Control Design Criteria.

Detention basins are natural or constructed basins that receive and hold storm water runoff to reduce downstream peak flows for flood control purposes and/or to enhance water quality. Detention basins are allowed only with the approval of the City Engineer. Publicly maintained storm water ponds with permanent pools of water are prohibited. However, approval may be granted provided the applicant/developer executes a binding agreement to provide funding, in perpetuity, for the maintenance costs associated with these facilities.

Detention basins should be designed to be multipurpose wherever possible and designed to enhance storm water quality. Detention basins whose primary purpose is water quality enhancement will be considered during planning for storm drain system improvements.

Publicly maintained detention facilities for flood control purposes may be permitted, with the approval of the City Engineer, when it is more cost-effective than providing storm drains. An analysis, which justifies the financial need for the detention basin by presenting both the estimated capital cost and the estimated annual operation and maintenance costs of the basin as well as comparable costs for an underground closed conduit storm drain system, shall be prepared under the direction of a civil engineer and submitted for approval by the City Engineer prior to approval of a tentative map. The City Engineer may prohibit or restrict the use of detention basins based on specific site conditions such as insufficient depth to bedrock; extreme community disruption; need for extensive relocation of existing improvements and utilities; or lack of sufficient, available, suitable land.

The design of detention basins for flood control purposes shall be based on the size of the basin; the maximum allowable depth of temporary ponding; the recurrence interval of the storm being considered; the peak rate, total volume, and timing of the inflow; the maximum allowable outflow rate; and the length of time water is allowed to remain in the basin. The design shall be accomplished through the development of three items: an inflow hydrograph, a depth-storage relationship, and a depth-outflow relationship. These three items shall be combined in a routing routine to obtain the outflow rate, depth of stored water, and volume of storage at any specific time as the design storm flow passes through the detention basin. Pumped discharges from publicly maintained detention facilities are prohibited.

The design considerations cited above determine the detention basin volume required for flood control purposes only. Design of detention basins should also take into consideration other benefits that can be achieved, such as water quality enhancement, recreational opportunities, and open space aesthetic enjoyment. Public health and safety needs should be considered, such as the need for vector control and fencing in particular applications. Detention basin designs must promote personal safety by locating basin along public streets to assure visual access to basin area. Site, street and basin design should be coordinated to orient buildings and streets for good surveillance of basin area.

The design of detention basins shall include the recommendations, considerations and procedures discussed in *Design and Construction of Urban Stormwater Management Systems,* Chapter 6, WEF Manual of Practice FD-20, latest edition, and ASCE EWRI *Guidance for Protection of Public Safety at Urban Stormwater Management Facilities.*

The geometry of the basin should be designed to reduce dead zones and increase detention times. Inlet and outlet structures must be carefully designed to reduce turbulence that could resuspend settled solids. Consideration should be given to installation of energy dissipaters, stilling basins, berms, and separation walls.

To prevent erosion during large storm flows, unprotected side slopes shall be no steeper than 3 horizontal:1 vertical. Lesser slopes as described *Design and Construction of Urban Stormwater Management Systems,* Chapter 6, WEF Manual of Practice FD-20, latest edition, and ASCE EWRI *Guidance for Protection of Public Safety at Urban Stormwater Management Facilities* are preferred. Slopes of 3:1 shall include a discussion of maintenance and safety provisions.

Detention basins shall be designed and constructed for easy access to the basin itself and all inlet and outlet structures. Access to the bottom of the basin is necessary. Basins to be maintained by City staff must meet City accessibility criteria discussed below under "Design Requirements."

DESIGN REQUIREMENTS

VIII. CONNECTION TO THE EXISTING STORM DRAIN SYSTEM

A. New storm drain systems must connect to an existing City or County of Sonoma storm drain facility, a channel or creek maintained by the SCWA, or an approved natural waterway. Storm drain designs shall incorporate the design of any off-site storm drain improvements required to accommodate flow from the storm drain system for the proposed development. A structure must be installed at each connection (i.e., no "blind" connections) except as otherwise approved by the City Engineer.

B. Where public storm drains must traverse private property, inlets necessary to drain the private property are permitted to connect to the public storm drain. These inlets and connecting pipes shall be clearly delineated as private on the improvement plans.

C. Sump pumps for non residential or mixed land uses shall not discharge to gutters or sidewalk drains. Sump pumps shall discharge into closed conduit systems or open channels, if permitted by the North Coast Regional Water Quality Control Board. Sump pumps for nonresidential land uses shall discharge at a structure (i.e., no blind connections). Sump pumps which may discharge liquids other than uncontaminated water (e.g., oil, grease, solvents, etc.) shall discharge to sanitary sewers, if approved by the City's Utilities Department; industrial pretreatment of these discharges may be required. Sump pumps for single-family residences shall be allowed to discharge to sidewalk drains or gutters by gravity flow only. (For instance, by pumping to a box and then allowing the water to gravity flow through curb into the gutter.)

D. Concentrated drainage flows in pipe systems from private property shall not flow over public sidewalks. Sidewalk drains or other means of collection and conveyance to a proper discharge location shall be provided.

IX. MATERIALS

A. Storm drain pipes 15 inches in diameter or larger shall be reinforced concrete pipe (RCP), or annular high density polyethylene (HDPE) pipe.

B. RCP shall be Class III, IV, or V as specified in Part 3, Public Storm Drain Construction Standard Specifications, of these standards.

Typical total effective loads on buried pipe, expressed in pounds per linear foot of pipe, are shown in Table I-3. The design engineer shall determine the D-load for the depth and diameter of pipe from the table and select the class of RCP with a D-load rating equal to or greater than the value in Table I-3. The design engineer shall interpolate between the values in Table I-3 for conditions not presented in the table.

C. HDPE pipe shall be smooth interior, corrugated exterior pipe with bell-and-spigot joints, Type S, per AASHTO Designation M294. HDPE pipe shall only be used in sizes of 36-inch or smaller diameter with cover of less than 30 feet. The design engineer shall determine flotation restraint per manufacturer's recommendations. Minimum cover over pipe shall be 12 inches from the outside top of pipe to subgrade. HDPE pipe shall only be used under pavement areas.

D. Sidewalk drains shall be per Standard 406.

X. SIZE

A. Storm drain pipe diameters within the public right-of-way, including driveway culverts, shall be 15 inches or larger, except sidewalk drains shall be per Standard 406.

B. In new portions of the storm drain system, pipe sizes shall not decrease in the downstream direction.

XI. ALIGNMENT

A. Storm drains shall be located within public streets unless otherwise authorized by the City Engineer.

B. Storm drains traversing private property shall be straight between manholes (i.e., no horizontal curves) except when installed in a private street parallel to the centerline of the private street.

C. In general, storm drains shall be installed parallel to the centerline of the street or right-of-way.

D. Horizontal separation of storm drain line from sanitary sewer shall be a minimum of 5 feet clear (i.e., outside of pipe to outside of pipe), except at pipe crossings.

E. Horizontal separation from water mains and other utilities, gas, underground electric, underground television cable, etc., shall be a minimum of 4 feet clear.

F. Vertical curves are not allowed unless specifically authorized by the City Engineer.

G. Horizontal curves with a minimum radius of 300 feet for RCP shall be provided at catch basins installed at curbs and gutters so as to locate as much of storm drain as possible under asphaltic concrete paving rather than concrete curbs and gutters.

H. Horizontal curves concentric with public or private street centerlines may be permitted with RCP provided the radius is 300 feet or greater. The minimum allowable radius used with 20 foot sections of HDPE pipe is 765 feet.

I. Horizontal curves can be installed in RCP by pulling pipe joints if the resulting deflections are not greater than the pipe manufacturer's recommendations. The design engineer shall use the following equation in designing horizontal curves for RCP with a diameter over 48 inches:

$$R = \frac{L}{2\left(\operatorname{Tan}\frac{\Delta}{2N}\right)}$$

where:

R = radius of curvature of the centerline of the pipeline in feet

L = laying length of pipe section in feet, measured along centerline

Δ = total deflection angle of curve in degrees

N = number of pipe sections with pulled joints

Δ/N = deflection angle of each pipe in degrees

XII. SLOPE

Maximum slope for storm drains shall be 10 percent or 10 feet per 100 feet.

XIII. COVER

Minimum cover over storm drains shall be 12 inches (Class III RCP and HDPE). Cover is defined as the distance from the outside top of the pipe to the final subgrade (bottom of the structural section) in paved areas or finished grade in unpaved areas. See Table I-3.

XIV. MANHOLES AND STRUCTURES

A. A manhole or accessible structure shall be installed at every change in pipe size.

B. The maximum distance between manholes and/or accessible structures shall be 400 feet.

C. A manhole or accessible structure shall be installed at every horizontal angle point or vertical change in alignment.

D. Sufficient drop shall be provided through manholes and accessible structures to compensate for energy loss caused by change of alignment.

E. Manholes shall be 48 inches in diameter with storm drain pipes of 36 inches in diameter or less, and shall be 60 inches in diameter with storm drain pipes larger than 36 inches in diameter. Manholes shall be designed to be large enough to accommodate all pipes connected to manhole with a minimum of 3 inches of manhole wall on both sides of all pipes. Reducer slabs may be provided as shown on Standard 401.

F. An accessible structure shall be provided to connect private storm drains to the public storm drains (i.e., no blind connections) except as otherwise approved by the City Engineer. Structures shall be installed on the private side of the property line to distinguish the public system from the private system. Public and private storm drain facilities shall be clearly identified on the improvement plans. For residential land uses only, no structure is necessary for sump pump connections to public storm drain systems. Accessible structures are required for sump pump connections from nonresidential land uses.

G. Headwalls or structures shall be provided where open ditches, channels, and creeks discharge into closed pipe conduits. Refer to Caltrans Standard Plans.

XV. CATCH BASINS

A. Catch basins shall be Type II (Standard 402) except as listed below or as otherwise approved by the City Engineer. Galleries per Standard 404 may be used on the upstream side of a Type II catch basin to increase inlet interception capacity or if their use reduces the number of catch basins requiring maintenance.

B. Catch basins shall be installed at the following locations:

- Such that gutter flows do not cross intersections except where valley gutters are allowed.
- Upstream of bridge abutments.
- The beginning of every roadway superelevation that reverses the cross-slope of the pavement.
- The sags (i.e., bottoms) of vertical curves
- The low points of downhill cul-de-sacs
- As required so that water depth in gutter does not exceed 0.4 feet during the 100-year design storm event.
- As required to maintain the following number of 8-foot-wide traffic lanes unimpeded by flowing or standing water during a 100-year design storm:
  - Two lanes for all regional streets.
  - One lane for transitional and industrial streets. This lane may be in the middle of the road, spanning the crown. This requirement does not apply to local streets.
  - One lane in each direction for transitional streets that are divided roads or roads with a median strip.
- As required so that carry over flows (bypassing catch basins) shall not exceed 2 cubic feet per second.

- At a maximum spacing of 400 feet from another catch basin or manhole.

C. Catch basin size and spacing shall be computed by the methods in Drainage of Highway Pavements, Federal Highway Administration, Hydraulic Engineering Circular No. 12, March 1984 or most current version.

D. Storm drain labels shall be affixed in accordance with City Engineer's Standard 409.

XVI. EASEMENTS

A. An easement must be provided over any public storm drain when it is installed outside a public right-of-way.

B. The easement must be a minimum of 15' wide if it only contains a publicly-maintained storm drain or 20' wide (or wider) if it contains another facility, such as water, sewer, or other utility. The easement will be dedicated as a "public drainage easement" if it contains storm drain only. It will be dedicated as a "public utilities easement" if it contains other facilities as well.

C. Easements must be configured to encompass all publicly-maintained appurtenances and will be generally centered over the facility. Separate access easements may be required depending on site conditions. When storm drains are to be installed along a property line the easement will be wholly contained on one parcel.

D. All property restrictions placed as a result of dedication of easements will be so noted on the supplemental sheet of the Subdivision Map, or on the Easement Deed if the easement is not dedicated as part of a subdivision. Typical required notes as applicable are:

1. No structures may encroach on, above, or below the surface of the ground in any public easement. This includes footings of foundations, eaves from the roof of any adjacent structure, pools, ponds or outbuildings on slabs or foundations.
2. No trees may be planted in a public storm drain easement without first obtaining approval of the Director of Public Works. Trees may be allowed to the extent that damage to the drainage system does not occur from root intrusion and adequate access can be provided for maintenance and repair vehicles.
3. The Public Works Department will take due caution when performing maintenance or repair of drainage systems in easements, but will not be responsible for repairs or replacement of trees, landscaping or structures not specifically approved by the Director of Public Works.

XVII. ACCESS ROADS

A. Clear access must be provided and maintained to all public structures on the drainage system.

B. All-weather vehicle access roads are required to every structure on the storm drain system. Access roads must be a minimum of 12' in width and must be provided with turnarounds per City Standard 206 when the back-up distance for any maintenance vehicle exceeds 100'.

C. The design of access roads must be included with the drainage system design plans. At a minimum, the design shall conform to the requirements of Standard 216. Include adequate drainage measures in the design to prevent damage to the access roads from storm water.

D. Gates must be provided for access through any fence crossing a public storm drain easement. Where vehicular access is required for maintenance, minimum 14' wide gates must be provided with sliding gates preferred. Where vehicular access is not required, 4' wide gates for pedestrian access must be provided and will be located to permit visual access between storm drain structures.

E. The maximum grade allowed at any point on an access road is 15%. The maximum cross-slope for any access is 5%.

XVIII. MAINTENANCE

A. Storm drains that convey public water, are designed and constructed to City standards, and are in a dedicated public easement or right-of-way accepted by the City shall be maintained for hydraulic capacity by the City. All other storm drains, including driveway culverts, shall be privately maintained.

B. Sidewalk drains shall be privately maintained by the owners of the frontage property.

XIX. WATER QUALITY TREATMENT

A. Source controls designed or constructed to reduce the discharge of pollutants from the storm water conveyance system shall be designed and maintained as directed by Development Services.

XX. OTHER REQUIREMENTS

A. Sanitary sewer laterals and industrial process or waste pipelines shall not be connected to storm drains or allowed to discharge to waterways. Sanitary sewer laterals and industrial waste pipelines shall be connected to sanitary sewers in conformance with the latest edition of the City's Sewer Standards; pretreatment of industrial wastes may be required.

B. Driveway culverts shall be designed under the direction of a civil engineer to convey anticipated flow from future development and ensure hydraulic adequacy.

Table I-1 Rational Method Runoff Coefficients (C)

	Average Slope, Percent			
Land Use	**0–2**	**>2–7**	**>7–15**	**>15**
Residential, Rural (1 unit per 5+ acres)	0.35	0.39	0.43	0.45
Residential, Very Low Density (1 unit per .5 to 5 acres)	0.40	0.43	0.46	0.50
Residential, Low Density (2 to 4 units per acre)	0.45	0.49	0.56	0.59
Residential, Medium-Low Density (4 to 8 units per acre)	0.50	0.56	0.64	0.70
Residential, Medium Density (8 to 18 units per acre)	0.70	0.74	0.77	0.80
Residential, Medium-High Density (18 to 30 units per acre)	0.90	0.90	0.90	0.90
Business, Commercial, Institutional and Schools	0.90	0.90	0.90	0.90
General Industrial	0.90	0.90	0.90	0.90
Parks and Recreation	0.31	0.37	0.42	0.45
Agricultural and Open Space	0.30	0.35	0.41	0.45

Note: Coefficients for developments with more than one land use shall be weighted in proportion to the areas of each land use using either the values from Table I-1 or the following formula in on-site design calculations. Off-site design calculations shall use the values from Table I-1.

$$C = Cv\ (Av/At) + 0.9(Ap/At)$$

Where:

Cv = value from the vegetated area curve, SCWA Plate No. B1
Av = vegetated area
Ap = impervious area
At = total area

SONOMA COUNTY WATER AGENCY

FLOOD AND DRAINAGE REVIEW
PLAN SUBMITTAL CHECKLIST

Project Name:____Date:________________
SCWA File #:____

<u>All of the following items</u> must be submitted before a flood and drainage review can be completed. Please submit the following items or indicate why they are not necessary.

- ☐ Transmittal Letter
- ☐ Explanation of Analysis Approach
- ☐ Submittal Information Sheet
- ☐ Plan Check Fee (minimum of 1/2 due; remainder due prior to final approval)
- ☐ Improvement Plans
- ☐ Final Map or Parcel Map (if applicable)
- ☐ Hydrology Map
- ☐ Establish Factors used in Analysis
- ☐ Hydrology Calculations ☐10-year Storm and ☐100-year Storm
- ☐ Hydraulic Calculations
- ☐ Establish Starting HGL
- ☐ ☐EGL and ☐HGL Plots
- ☐ 100-year Storm Routing
- ☐ 100-year Storm Elevations vs. Finished Floor Elevations
- ☐ Inlet Capacity Calculations
- ☐ Curb Water Depth Calculations
- ☐ Assessor Parcel Map with Site Outlined
- ☐ Copy of the conditions of approval for the project

rs3\u\c\fdr\checkls2.doc
12/10/02

Figure I-1 INTENSITY-DURATION-FREQUENCY

(see following page)

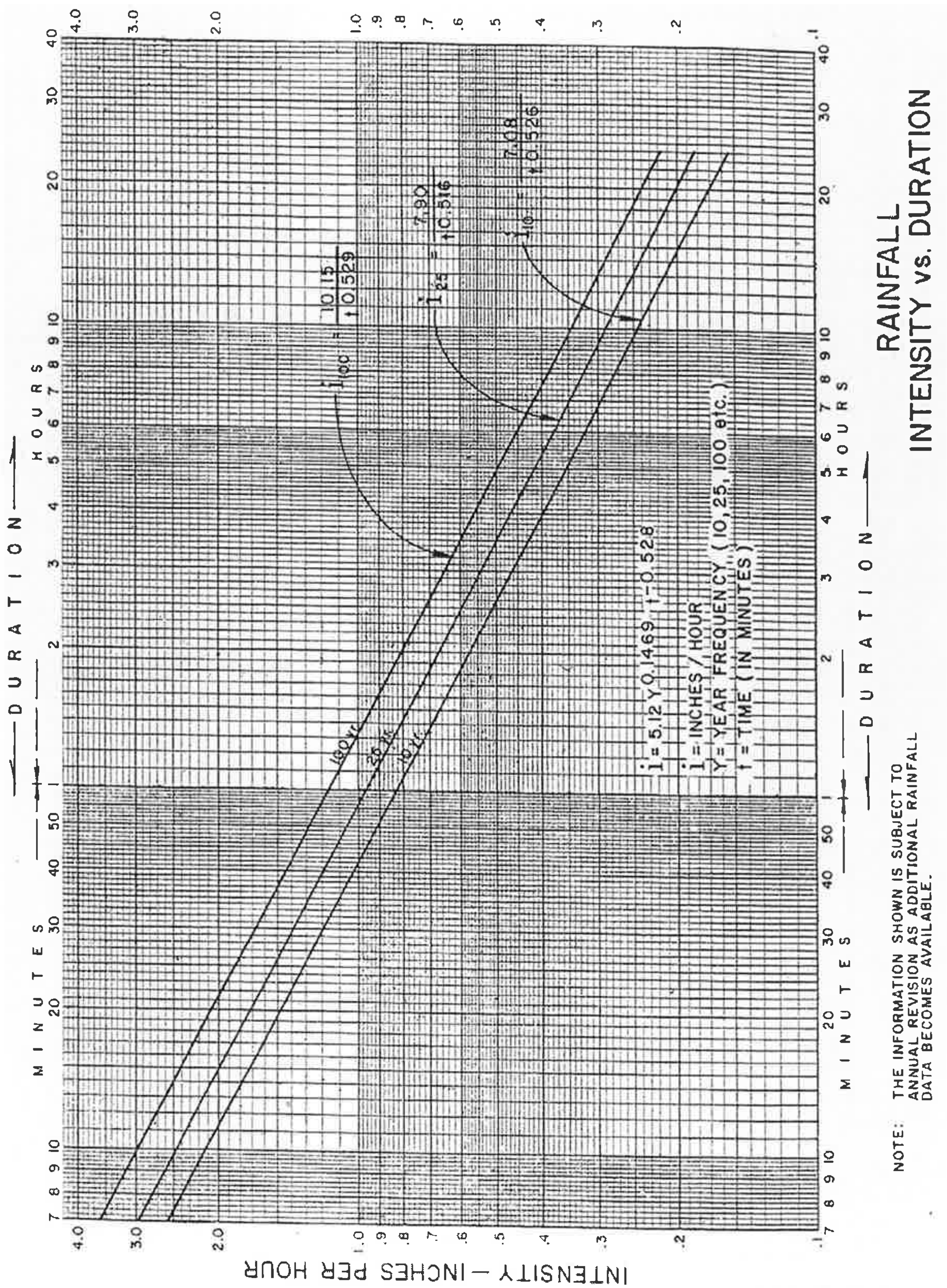

PLATE No. B-2

(ORIGINAL TO BE OBTAINED FROM SONOMA COUNTY WATER AGENCY)

Table I-3 LOADS ON BURIED PIPES

POUNDS PER LINEAR FOOT

Cover to Subgrade / Pipe Diameter In Inches

in feet	15	18	21	24	27	30	36	42	48	54	60	66	72	78	84	90	96	102	108
1	*	*	*	*	*	*	*	*	*	2919	2310	2475	2310	2169	2048	1944	1852	1778	1705
2	1632	1592	1549	1516	1491	1471	1474	1289	1148	1039	952	881	822	772	729	692	659	633	607
3	931	893	859	834	814	798	827	814	797	784	731	688	652	622	596	573	553	540	524
4	857	816	780	753	733	716	760	742	723	709	699	691	685	658	636	616	599	589	576
5	878	832	794	766	744	726	784	763	742	726	715	706	699	693	687	683	667	660	647
6	921	874	833	803	780	762	835	812	789	771	759	749	741	735	729	724	719	727	720
7	974	924	883	852	828	809	897	872	848	829	816	806	798	790	784	779	775	782	778
8	1029	978	935	904	880	861	964	939	913	893	880	869	861	853	847	842	837	846	842
9	1087	1036	993	961	937	918	1037	1011	985	964	951	940	932	924	918	913	908	918	914
10	1141	1090	1047	1015	992	973	1108	1082	1055	1034	1021	1011	1002	995	989	984	979	991	987
11	1191	1141	1098	1067	1043	1026	1177	1151	1123	1103	1090	1080	1072	1065	1059	1054	1050	1063	1059
12	1236	1187	1145	1115	1092	1075	1242	1217	1190	1170	1157	1148	1140	1134	1128	1124	1120	1135	1131
14	1315	1269	1229	1201	1181	1166	1365	1343	1317	1297	1287	1279	1272	1267	1263	1260	1257	1275	1272
16	1380	1338	1301	1276	1259	1247	1477	1458	1434	1417	1409	1403	1398	1395	1393	1391	1389	1411	1409
18	1433	1396	1363	1341	1327	1318	1578	1564	1543	1528	1523	1519	1517	1516	1516	1516	1516	1542	1542
20	1477	1445	1415	1397	1386	1380	1670	1661	1643	1631	1629	1629	1630	1631	1633	1635	1637	1668	1669
24	1542	1519	1496	1485	1482	1483	1828	1830	1820	1816	1821	1828	1835	1842	1850	1857	1863	1903	1908
28	1585	1570	1554	1550	1553	1560	1955	1969	1969	1973	1987	2002	2016	2030	2043	2056	2068	2118	2126
32	1613	1605	1595	1597	1606	1619	2058	2085	2094	2107	2130	2153	2175	2196	2216	2235	2253	2313	2326
36	1632	1629	1624	1631	1646	1664	2141	2180	2198	2220	2253	2285	2315	2343	2371	2396	2420	2490	2509
40	1644	1645	1644	1656	1675	1698	2208	2258	2286	2317	2359	2399	2437	2474	2508	2540	2571	2651	2675

Allowable Loads:
Class III 1,350 pounds/linear foot
Class IV 2,000 pounds/linear foot
Class V 3,000 pounds/linear foot

The area within the heavy black line indicates situation where Class III RCP is acceptable.

* Exceeds the capacity of Class V RCP. Special design required to be submitted to City Engineer.

Reference: Ameron Reinforced Concrete Pressure Pipe, 1971, for covers of 2 feet or greater. Loads are interpolated for covers of 1 foot.

L:\Storm Drain Standards\pipe loading chart.xls -19- TABLE I-3