Appendix K:
Utilities Supporting Information

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K.1 - Preliminary SWLIDS Report

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PRELIMINARY SWLIDS REPORT

ELNOKA CCRC

251 ELNOKA LANE

SANTA ROSA, CA 95409

APN'S 031-050-014, 031-050-018, 031-050-019, 031-061-003, 031-050-060 THOUGH 031-050-072

OAKMONT SENIOR LIVING LLC

B&R JOB # 2854.04

MAY 2017

Prepared By:

Brelje & Race Consulting Engineers

475 Aviation Blvd., Suite 120

Santa Rosa, CA 95403

v. 707.576.1322 f. 707.576.0469

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Attachments

1. LID proposed Condition Exhibits

PROJECT DESCRIPTION

The Elnoka CCRC project is the site of the previously approved and partially implemented Three Bridges Lifecare Community. The project is located on State Highway 12, east of Melita Road in the City of Santa Rosa. The project site totals 68.73± acres on 17 parcels. The site is bounded my state Highway 12 to the north, Oakmont HOA to the east, Channel drive and residences to the North, and Melita Road and residences to the west.

The site's topography has moderate slopes averaging 19%. The site has a high point that runs east west, and divides the site approximately in half, north and south. Oakmont Creek flows east to west through the southerly portion of the site. The South Fork of Melita Creek runs east to west through the northerly portion of the site. The South Form of Melita Creek intersect with the main fork of Melita Creek on the western portion of the site. The northern portion of the site was previously graded by the Three Bridges Lifecare Community project in 1996/1997, an arch span culvert was built over the South Form of Melita Creek in conjunction with creek capacity/widening improvements that were constructed within the South Fork of Melita Creek. The site is primarily covered by annual grasses numerous trees mostly concentrated around each of the creeks that run through the project site. The site currently drains overland from the central high point running through the site, towards the existing creeks in their respective portions of the site. A storm drainage system was installed as part of the previously planned development, with outlets at both Melita South Fork and Melita creeks. The existing storm drainage system is intended to collect the increased stormwater flows from the developed site.

The Soil Map on the following page was generated using the USDA Natural Resource Conservation Service Web Soil Survey. The soil classification for the project area is a mixture of Tuscan cobbly Clay loam (TuE), Riverwash (RnA), Pleasanton loam (PnB), Pleasanton clay loam (PhB) and Manzanita gravelly silt loam (MbC). These soil types are classified as hydrologic soil group C except for Tuscan clay loam which is classified as D soil, and Riverwash. Riverwash has no hydrologic soil group, but given its listed properties as "well drained", a hydraulic soil Group of B has been assigned for the calculations in this report.

The project site will be developed to accommodate 14 senior living apartment buildings, a recreation center, 2 employee housing buildings, 74 cottages, and a care center facility. The exterior improvements will include a pool and patio area, as well as associated roadways, driveways, sidewalks, parking areas, landscaping, storm drainage, water (potable, fire protection, and irrigation) and sanitary sewer. The project is classified as a residential development and triggers these storm water requirements by creating over 10,000 ft^2 of new impervious surface.

Pollution Prevention Measures

The project design has incorporated pollution source controls intended to prevent pollutants from entering downstream drainage systems. These source controls include:

- Drainage inlets and structural BMP's will be fitted with gross pollutant (trash) racks and interceptor trays. Racks and trays will be regularly inspected and any captured debris removed and properly disposed of.

- The site landscape and hardscape will be professionally maintained, swept clean and with landscape leaves and debris removed on a regular schedule over the course of the year.

- Trash will be stored in a covered exterior trash enclosure. Local drainage will be routed away from the trash enclosure location.

- Vehicles will not be allowed to be washed or mechanically maintained on the site. All such activities will be required to occur off-site with encouragement of the use of commercial car-washes and car maintenance and repair shops.

- Landscape irrigation heads will be sized and tuned to avoid overspray and overwatering along with the selected use of drip irrigation.

- Capture and retention of at least the runoff from the 85th percentile storm event to the maximum extent practicable (MEP) of the entire site

- Routing excess intercepted runoff to sheet drain downslope through adjacent existing vegetation.

Types of BMP's

The MS4 Permit's goal is to treat, capture and infiltrate 100% of the runoff generated by the one inch deep 85th percentile 24-hour storm (design storm). The LID strategies and BMPs proposed for use on this project includes new tree planting, preservation of existing trees, bioretention planters, treepod bioretention structures and underground stormwater retention/infiltration basins. See text below for more details on proposed LID strategies and BMPs.

Interceptor Trees -New Tree Planting

Tree planting has been shown to reduce the amount of runoff that comes off a developed project Tree canopies intercept storm water before it contacts the ground and retain a significant volume of captured water on their leaves and branches allowing for evapotranspiration and providing runoff reduction benefits. While the most effective interceptor trees are large canopied evergreen trees, deciduous trees can also provide a measurable benefit. The proposed project includes the planting of many trees within the proposed Improvements.

Interceptor tree credits are calculated into the site design by reducing the amount of tributary area that must be used to calculate treatment and volume capture. New deciduous trees provide a credit of 100 square feet, new evergreen trees provide 200 square feet. All interceptor tree credits calculations are completed with the Credit Calculator of the Storm Water Calculator.

Interceptor Trees -Preservation of Existing Trees

Preserving existing established tree canopies has been shown to reduce the amount of runoff that comes off a developed project. Existing tree canopies intercept storm water before it contacts the ground and retain a significant volume of captured water on their leaves and branches allowing for evapotranspiration and providing runoff reduction benefits. The proposed project will preserve many of the large oak trees that exist on the existing project site.

Interceptor tree credits are calculated into the site design by reducing the amount of tributary area that must be used to calculate treatment and volume capture. All interceptor tree credits calculations are completed with the Credit Calculator of the Storm Water Calculator.

Bioretention Planters

Bioretention planters will consist of excavated areas backfilled with permeable granular material, sandy loam and top soil. Planters will be landscaped with native vegetation that will maximize evapotranspiration. Bioretention areas are to be designed in general accordance with the City of Santa Rosa and County of Sonoma "Storm Water Low Impact Development Technical Design Manual". The proposed bioretention areas will be designed with 18" of a sandy loam mix over of class 2 permeable material. A perforated sub drain will be located near the top of the permeable material for priority 2 bioretention adjacent to paving areas. The permeable material will maximize storm water runoff retention and storm water infiltration.

Pervious Concrete Gutter/ Valley Gutter Bioretention Areas.

Proposed Pervious Concrete Gutter/Valley Gutter bioretention areas are designed in accordance with the City of Santa Rosa and County of Sonoma "Storm Water Low Impact Development Technical Design Manual". Proposed Pervious Concrete Gutter/Valley Gutter will be installed with a minimum of 18" of CU structural treatment soil over a perforated subdrain which will be install on top of another layer of class 2 permeable material. The upper layer of material will provide stormwater treatment and the lower layer of class 2 permeable material below the sub drain will provide storm water retention. The perforated sub drain will be installed to drain the upper layer of class 2 permeable material to prevent stormwater from entering the roadway subgrade and road section. The class 2 permeable material will maximize storm water runoff retention and storm water infiltration. Within each storm drain inlet that collects storm water from pervious concrete gutter/ valley gutter bioinfilltration areas there will be a trash collection bucket and Flogard catch basin insert filter that will collect trash and sediment before storm water is discharged the storm drain system.

Kristar Cudo Retention/Infiltration Basins

Kristar Cudo retention/infiltration basins systems will be connected to onsite treepod bioretention structures to provide a storm water treatment and storm water retention. The Kristar Cudo retention/infiltration basin is a modular system of stackable 2'x2'x2' cubes that creates an underground retention storage area that contains 95% void space. The top sides and bottom of the modular cubes are not enclosed and have a grated cover that allows storm water to infiltrate into the surrounding soils all sides. The Kristar Cudo modular cubes will be wrapped with a filter fabric and backfilled with a 1' thick section of drain rock on the top, bottom and all four sides to prevent the surround sediment from entering the modular storm water retention area. Each Kristar Cudo retention/infiltration basin will have at least one manhole opening to allow inspection, access and cleaning the voids contained within the modular Cudo retention and infiltration basin. The Kristar Cudo retention/infiltration basins functions similar to the retention portion of a standard bio-retention planter but contain a greater quantity of voids. The Kristar Cudo basins will promote storm water infiltration and additional storm water treatment. The Kristar Cudo underground retention/infiltration basins that will be sized to capture the 100% Volume capture requirement of each area. At each storm drain outfall into the Kristar Cudo basins there will be a trash collection bucket and Flogard catch basin insert filter that will collect trash and sediment before storm water is discharged to the storm drain system.

Impervious Area Disconnection

Impervious area disconnection allow storm water from impervious areas, such as rooftops and pavement, to be directed to pervious natural or landscaped areas and infiltrate into the soil. All landscape areas where impervious area disconnections are proposed will be amended with compost (mixed into the soil with a rototiller) to a depth of 8 inches to allow for storm water treatment and infiltration before reaching a storm drain inlet. This BMP also slows the speed and amount of runoff from a site over conventional direct storm drain connections. All rooftop drainage for this project shall be disconnected from direct connection to the storm drain system and will be directed to storm drain treatment areas utilizing splash blocks or curb drains to paved areas that allow sheet flow to bio-retention areas.

Level of Treatment and Volume Capture

The design goal of 100% capture for the overall site will be achieved by routing 100% of event runoff (or as near to 100% as possible) through the various BMP's associated with each of the DMA's around the project. In addition, BMP's will be designed to retain at minimum the volume of runoff generated by the 1 inch deep 85th percentile event directed into each BMP before bypassing any excess runoff. A 100 square foot type B bioretention planter is proposed in the rear yard of almost all of the proposed cottages on the Elnoka project site (these areas are defined as DMA #60 (typ)). The type B bioretention planters were sized using the largest cottage footprint and applying that size bioretention planter to all of the cottages. The type B bioretention planters at each cottage will treat and retain the one inch 85% percentile storm event runoff from the cottage roof, patio and sidewalks. Each of the cottage driveways will

drain to the proposed site roads and the stormwater will be treated and retained by the proposed roadway BMP's

Maintenance Funding

BMPs shall be inspected and maintained as described in "Planter Strip Bioretention Inspection and Maintenance Checklist", "Porous Pavement Inspection and Maintenance Checklist" and "Interception Trench Inspection and Maintenance Checklist provided in the **LID** Manual Reference Documents Section. Structural BMP's such as the "Cudo" unit arrays shall be inspected and maintained in accordance with the operations and maintenance (O&M) manual published by the manufacturer. All associated costs for inspection or maintenance of the onsite best management practices (BMPs) shall be budgeted for this purpose and carried out by Oakmont Senior Living LLC., or its assigned successor(s).

FOR OFFICE USE ONLY:
Does this project require permanent storm water BMP's?

☐ Y ☐ N

Date Submitted: _____

Print Form

File No:	Quadrant
Related Files:	
Set:	
Department Use Only	

2017 Storm Water LID Determination Worksheet

PURPOSE AND APPLICABILITY: Use this form to determine whether or not this project will need to incorporate permanent Storm Water Best Management Practices (BMP's) and submit a Storm Water Low Impact Development Submittal (SW LIDS) as required by the City's National Pollutant Discharge Elimination System Municipal Separate Storm Sewer Systems (NPDES MS4) only. Your project may still need to incorporate permanent storm water BMP's as required by other regulatory authority, such as, but not limited to CALGREEN or North Coast Reqional Water Quality Control Board (NCRWQCB).

Part 1: Project Information

Elnoka CCRC	OSL Santa Rosa Projects LLC
Project Name	Applicant (owner or developer) Name
251 Elnoka Ave.	9240 Old Redwood Hyw, Suite 200
Project Site Address	Applicant Mailing Address
Santa Rosa/ Ca/ 95409	Windsor, Ca 95492
Project City/State/Zip	Applicant City/State/Zip
N/A	707-535-3500
Permit Number(s) - (if applicable)	Applicant Phone/Email/Fax
Brelje & Race Consulting Engineers	475 Aviation Blvd, Suite 120
Designer Name	Designer Mailing Address
Santa Rosa, Ca, 95403	707-576-1322/ Gleason@brce.com
Designer City/State/Zip	Designer Phone/Email

Type of Application/Project:

☐ Subdivision ☐ Grading Permit ☐ Building Permit ☑ Hillside Development

☑ Design Review ☑ Use Permit ☐ Encroachment ☐ Time Extensions ☐ Other :_____

PART 2: Project Exemptions

1. Is this a project that creates or replaces *less than* 10,000 square feet of impervious surface[1], including all project phases and off-site improvements?

   ☑ Yes ☐ No

1 Impervious surface replacement, such as the reconstruction of parking lots or excavation to roadway subgrades, is not a routine maintenance activity. Reconstruction is defined as work that replaces surfaces down to the subgrade. Overlays, resurfacing, trenching and patching are defined as maintenance activities per section ??????

2. Is this project a routine maintenance activity[2] that is being conducted to maintain original line and grade, hydraulic capacity, and original purpose of facility such as resurfacing existing roads and parking lots?Is
3. this project a stand alone pedestrian pathway, trail or off-street bike lane?

☐ Yes ☑ No

4. **Did you answer "YES" to any of the questions in Part 2?**

☑ **YES:** This project does *not* need to inclrporate permanent Storm Water BMP's as required by the NPDES MS4 Permit. **Please complete Section 4 and "Exemption Signature Section" on Page 4.**

☐ **NO:** Proceed with worksheet.

Part 3: Project Triggers

Projects that Trigger Requirements:
Please answer the following questions to determine whether this project requires permanent Storm Water BMP's and the submittal of a SW LIDs as required by the NPDES MS4 Permit order # ???????

1. Does this project create or replace a combined total of 10,000 square feet or more of impervious surface[1] including all project phases and off-site improvements?

☑ Yes ☐ No

2. Does this project create or replace a combined total or 10,000 square feet or more of impervious streets, roads, highways, or freeway construction or reconstruction[3]? ☑ Yes ☐ No

3. Does this project create or replace a combined total of 1.0 acre or more of impervious surface[1] including all project phases and off-site improvements? ☑ Yes ☐ No

4. **Did you answer "YES" to any of the above questions in Part 3?**

☑ **YES:** This project does *not* need to incorporate permanent Storm Water BMP's as required by the NPDES MS4 Permit. **Please complete Section 4 and "Exemption Signature Section" on Page 4**

☐ **NO:** This project will *not* need to incorporate permanent Storm Water BMP's as required by the NPDES MS4 permit. **Please complete the"Exemption Signature Section" on Page 4**.

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1 Imprevious surface replacement, such as the reconstruction of parking lots or excavation to roadway subgrades, is not a routine maintence activity. Reconstruction is defined as work that replaces surfaces down to the subgrade. Overlays, resurfacint, trenching and patching are defined as maintenance activities.

2 "Rountine Maintenance Activity" includes activities such as overlays and/or resurfacing of existing roads or parking lots as well as trenching and patching activities and reroofing activities.

3 "Reconstruction" is defined as work that extends into the subgrade of a pavement section.

Part 4: Project Description

1. Total Project area: 68.73 ◯ square feet ◯ acres

2. Existing land use(s): (check all that apply)

☐ Commercial ☐ Industrial ☑ Residential ☐ Public ☐ Other

Description of buildings, significant site features (creeks, wetlands, heritage trees), etc.:

There are 3 existing single family homes on the project with associated paved driveways. Oakmont Creek South flows through the northerly portion of the site. Melita Creek South Fork runs through the northerly portion of the site. Melita Creek runs through the Westerly portion of the site. There are numerous Oak trees on the project site.

3. Existing impervious surface area: 1.90 ◯ square feet ◯ acres

4. Proposed Land Use(s): (check all that apply)

☐ Commercial ☐ Industrial ☑ Residential ☐ Public ☐ Other

Description of buildings, significant site features (creeks, wetlands, heritage trees), etc.:

The project proposes to construct a senior housing community consisting of 74 cottages, 13 apartment buildings with 528 units, a care center consisting of 62 units, a recreation center, a maintenance building and a 12 unit employee housing building. The project will also build a a private road network, private sewer system, private storm drain system and public water system.

5. Proposed impervious surface area: 28.50 ◯ square feet ◯ acres

Project Name

2017 Storm Water LID Determination Worksheet | Elnoka CCRC

Acknowledgment Signature Section:

As the property owner or developer, I understand that this project is required to implement permanent Storm Water Best Management Practices and provide a Storm Water Low Impact Development Submittal (SW LIDS) as required by the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) Permit.* Any unknown responses must be resolved to determine if the project is subject to these requirements.

_____ _____

Applicant Signature Date

Exemption Signature Section:

As the property owner or developer, I understand that this project as currently designed does not require permanent Storm Water BMP's nor the submittal of a Storm Water Low Impact Development Submittal (SW LIDS) as required by the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) Permit*. I understand that redesign may require submittal of a new Determination Worksheet and may require permanent Storm Water BMP's.

_____ _____

Applicant Signature Date

* **Your project may still need to incorporate permanent storm water BMP's as required by other regulatory authority, such as but not limited to CALGREEN or North Coast Reqional Water Quality Control Board (NCRWQCB).**

_____

Implementation Requirements: *All calculations shall be completed using the "Storm Water Calculator" available at: www.srcity.org/stormwaterLID*

Hydromodification Control/100% Volume Capture: Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by a 1.0" 24-hour storm event, as calculated using the "Urban Hydrology for Small Watersheds" TR-55 Manual method. 100% volume capture is the ideal condition and if achieved satisfies all requirements so that no additonal treatment is required. This is a retention requirement.

***Treatment Requirement*:** Treatment of 100% of the flow calculated using the modified Rational Method and a known intensity of 0.20 inches per hour.

Delta Volume Capture Requirement: Capture (infiltration and/or reuse) of the increase in volume of storm water due to development generated by a 1.0" 24-hour storm event, as calculated using the "Urban Hydrology for Small Watersheds" TR-55 Manual method. This is a retention requirement.

BMP Selection Table

	Best Management Practice (BMP)	Detail Sheet	Detail Title	Can be used with...	High Ground Water Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in priority selected?	Yes	No	Explanation of selection	Other notes:
Universal LID Features- to be considered on all projects.	Living Roof	N/A	N/A		x	x	x		x	x			X		
	Rainwater Harvesting	N/A	N/A		x	x	x			x			X		
	Interceptor Trees	N/A	N/A		x	x	x				x		X		
	Vegetated Buffer Strip	UN-01	Vegetated Buffer Strip								x		X		
	Bovine Terrace	UN-02	Bovine Terrace		x						x		X		
	Impervious Area Disconnection	N/A	N/A		x	x	x				x		X		

BMP Selection Table

	Best Management Practice (BMP)	Detail Sheet	Detail Title	Can be used with...	High Ground Water	Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in this priority selected?	Yes	No	Explanation of selection	Other notes:
Priority 1 and 1A BMPs- to be installed with no underdrains or liners. Must drain all stading water within 72 hours.	Rain Garden	P1-01	Rain Garden						x	x				X		
	Roadside Bioretention	P1-02	Roadside Bioretention - no C & G						x	x				X		
	Vegetated Swale-with Bioretention	P1-06	Swale with Bioretention						x	x				X		
	Constructed Wetlands	N/A	N/A						x	x				X		
	Infiltration Trench	P1-07	Infiltration Trench						x	x			X			

BMP Selection Table

	Best Management Practice (BMP)	Detail Sheet	Detail Title	Can be used with...	High Ground Water	Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in this priority selected?	Yes	No	Explanation of selection	Other notes:
Priority 2 BMPs- with subsurface drains installed above the capture volume.	Rain Garden	P2-01	Rain Garden						x	x				X		
	Roadside Bioretention	P2-02	Roadside Bioretinton - Flush Design Roadside						x	x			X			
		P2-03	Roadside Bioretenion- Contiguous SW						x	x			X			
		P2-04	Roadside Bioretenion- Curb Opening						x	x				X		
		P2-05	Roadside Bioretenion- No C & G						x	x				X		
	Pervious Pavement	P2-06	Vegetated Buffer Strip						x	x				X		
	Constructed Wetlands	N/A	N/A						x	x				X		

BMP Selection Table

	Best Management Practice (BMP)	Detail Sheet	Detail Title	Can be used with...	High Ground Water	Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in this priority selected?	Yes	No	Explanation of selection	Other notes:
Priority 3 BMPs- installed with subdrains and/or impermeable liner. Does not achieve volume capture and must be used as part of a treatment train.	Rain Garden	P3-01	Rain Garden		x	x	x		x					X		
	Bioretention	P3-02	Roadside Bioretinton - Flush Design Roadside		x	x	x		x					X		
		P3-03	Roadside Bioretenion- Contiguous SW		x	x	x		x					X		
		P3-04	Roadside Bioretenion- Curb Opening		x	x	x		x					X		
		P3-05	Roadside Bioretenion- No C & G		x	x	x		x	x				X		
	Flow Through Planters													X		
	Pervious Pavement	P1-04	Vegetated Buffer Strip		x	x	x		x	x				X		
	Vegetated Swale	P3-07	Vegetated Swale		x	x	x		x	x				X		

BMP Selection Table

	Best Management Practice (BMP)	Can be used with...	High Ground Water	Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in this priority selected?	Yes	No	Explanation of selection	Other notes:
Priority 4 BMPs- does not achieve volume capture and must be used as part of a treatment train.	Tree Filter Unit		x	x	x		x					X		
	Modular Bioretention		x	x	x		x					X		
Priority 5 BMPs- does not achieve volume capture and must be used as part of a treatment train.	Chambered Separator Units		x	x	x		x					X		
	Centrifugal Separator Units		x	x	x		x					X		
	Trash Excluders		x	x	x		x					X		
	Filter Inserts		x	x	x		x					X		
Priority 6 BMPs-	Offset Program						N/A	N/A	N/A					
Other	Detention		x											

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #1

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **20,850** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(20,850 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(20,850 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	20,850	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	20,850	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	20,850	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.61571 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05473 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.62)]^2}{[(1.00 * 1.17)+(0.8 * 0.62)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1141.12 ft^3

V_{GOAL}= (0.05473)(20,850)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

Input:

A_r =	20,850	ft^2 =	0.47865 Acres
C_{POST} [10] =	0.60		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.06720 cfs**

$Q_{TREATMENT}$= (0.2)(0.4787)(0.60)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	20,850	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 62.76 ft^3

V_{PRE}= (0.00301)(20,850)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.61571 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04807 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.62)]^2}{[(0.92*1.17)+(0.8*0.62)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1002.26 ft^3

V_{POST}= (0.04807)(20,850)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,002.26) - (62.76)

V_{DELTA}= 939.50 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #2

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **24,049** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(24,049 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(24,049 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] *From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).*

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	24,049	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	24,049	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,049	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.67236 in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	0.05243 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.67)]^2}{[(1.00 * 1.17)+(0.8 * 0.67)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1260.89 ft^3	V_{GOAL}=	(0.05243)(24,049)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	24,049 ft^2 =	0.55209	Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07622 cfs

$Q_{TREATMENT}$= (0.2)(0.5521)(0.59)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,049	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 72.39 ft^3

V_{PRE}= (0.00301)(24,049)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.67236 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04590 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.67)]^2}{[(0.92*1.17)+(0.8*0.67)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1103.85 ft^3

V_{POST}= (0.04590)(24,049)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,103.85) - (72.39)

V_{DELTA}= 1031.46 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2865.66 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 900.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,261 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.2 ft	Below perforated pipe if present
W =	30.0 ft	
L =	30.0 ft	

Solution:

Percent of Goal Achieved = 100.50 % = [(3.2 x 900) / 2,866] x 100

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1031.46 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #3

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **48,548** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(48,548 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(48,548 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area
Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	48,548	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	48,548	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	48,548	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05198 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.68)]^2}{[(1.00 * 1.17)+(0.8 * 0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 2523.53 ft^3

V_{GOAL}= (0.05198)(48,548)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	48,548 ft^2 =	1.11	Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.15387 cfs

$Q_{TREATMENT}$= (0.2)(1.11)(0.59)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	48,548	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 146.13 ft^3

V_{PRE}= (0.00301)(48,548)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04548 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.68)]^2}{[(0.92*1.17)+(0.8*0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 2207.96 ft^3

V_{POST}= (0.04548)(48,548)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (2,207.96) - (146.13)

V_{DELTA}= 2061.83 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 5735.28 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1554.72 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 2,524 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.7 ft	Below perforated pipe if present
W =	39.4 ft	
L =	39.4 ft	

Solution:

Percent of Goal Achieved = 100.30 % = [(3.7 x 1,555) / 5,735] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 2061.83 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

34

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #4

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **12,728** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(12,728 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(12,728 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	12,728	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	12,728	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,728	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	96

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.38422 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.06766 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.38)]^2}{[(1.00 * 1.17)+(0.8 * 0.38)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 861.18 ft^3

$V_{GOAL} = (0.06766)(12,728)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	12,728	ft^2 =	0.29219 Acres
C_{POST} [10] =	0.66		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.04513 cfs**

$Q_{TREATMENT}$= (0.2)(0.2922)(0.66)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,728	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	96

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 38.31 ft^3

V_{PRE}= (0.00301)(12,728)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.38422 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.06042 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.38)]^2}{[(0.92*1.17)+(0.8*0.38)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 769.03 ft^3

V_{POST}= (0.06042)(12,728)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (769.03) - (38.31)

V_{DELTA}= 730.71 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1957.22 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 484.88 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 861 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.0 ft	Below perforated pipe if present
W =	22.0 ft	
L =	22.0 ft	

Solution:

Percent of Goal Achieved = 100.09 % = [(4.0 x 485) / 1,957] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 730.71 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

40

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #5

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **22,393** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(22,393 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(22,393 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	22,393	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	22,393	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,393	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	85

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.75 in

$$S_{POST} = \frac{1000}{85} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02180 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.75)]^2}{[(1.00 * 1.17)+(0.8 * 1.75)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 488.17 ft^3

V_{GOAL}= (0.02180)(22,393)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	22,393	ft^2 =	0.51407 Acres
C_{POST} [10] =	0.38		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.04571 cfs

$Q_{TREATMENT}$= (0.2)(0.5141)(0.38)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,393	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	85

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 67.40 ft^3

V_{PRE}= (0.00301)(22,393)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.75 in

$$S_{POST} = \frac{1000}{85} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.01776 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.75)]^2}{[(0.92*1.17)+(0.8*1.75)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 397.70 ft^3

V_{POST}= (0.01776)(22,393)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (397.70) - (67.40)

V_{DELTA}= 330.30 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1109.47 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 595.36 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 488 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.9 ft	Below perforated pipe if present
W =	24.4 ft	
L =	24.4 ft	

Solution:

Percent of Goal Achieved = 101.96 % = [(1.9 x 595) / 1,109] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 330.30 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #6

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **25,625** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(25,625 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(25,625 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] *From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).*

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	**25,625**	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	**0.00**	ft^2
Reduced Tributary Area to be used for Calculations =	**25,625**	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	**25,625**	ft^2
K [7] =	**1.17**	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	**C: 0.05 - 0.15 in/hr infiltration (transmission) rate**
Select post development ground cover description [5] =	**Impervious - Paved Parking, Rooftop, Driveways**

CN_{POST} =	**98**	
OR: Composite post development CN [9] =	**90**	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	**1.06** in	S_{POST}=	$\frac{1000}{90} - 10$
Q_{POST}=	**0.03790** ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.06)]^2}{[(1.00 * 1.17)+(0.8 * 1.06)]} \times \frac{1ft}{12in}$
V_{GOAL}=	**971.19** ft^3	V_{GOAL}=	(0.03790)(25,625)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	25,625	ft^2 =	0.58827 Acres
C_{POST} [10] =	0.51		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07020 cfs

$Q_{TREATMENT}$= (0.2)(0.5883)(0.51)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	25,625	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	90

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 77.13 ft^3

V_{PRE}= (0.00301)(25,625)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.06 in

$$S_{POST} = \frac{1000}{90} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03236 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.06)]^2}{[(0.92*1.17)+(0.8*1.06)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 829.23 ft^3

V_{POST}= (0.03236)(25,625)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (829.23) - (77.13)

V_{DELTA}= 752.09 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2207.24 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 882.09 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 971 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.5 ft	Below perforated pipe if present
W =	29.7 ft	
L =	29.7 ft	

Solution:

Percent of Goal Achieved = 100.31 % = [(2.5 x 882) / 2,207] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 752.09 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #7

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **25,490** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(25,490 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(25,490 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	**25,490**	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	**0.00**	ft^2
Reduced Tributary Area to be used for Calculations =	**25,490**	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	**25,490**	ft^2
K [7] =	**1.17**	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	**C: 0.05 - 0.15 in/hr infiltration (transmission) rate**
Select post development ground cover description [5] =	**Impervious - Paved Parking, Rooftop, Driveways**

CN_{POST} =	**98**	
OR: Composite post development CN [9] =	**93**	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	**0.74114** in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	**0.04940** ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.74)]^2}{[(1.00 * 1.17)+(0.8 * 0.74)]} \times \frac{1ft}{12in}$
V_{GOAL}=	**1259.21** ft^3	V_{GOAL}=	(0.04940)(25,490)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	25,490	ft^2 =	0.58517 Acres
C_{POST} [10] =	0.58		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07942 cfs

$Q_{TREATMENT}$= (0.2)(0.5852)(0.58)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	25,490	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 76.72 ft^3

V_{PRE}= (0.00301)(25,490)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.74114 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04305 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.74)]^2}{[(0.92*1.17)+(0.8*0.74)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1097.34 ft^3

V_{POST}= (0.04305)(25,490)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,097.34) - (76.72)

V_{DELTA}= 1020.62 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2861.83 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 650.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,259 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.4 ft	Below perforated pipe if present
W =	25.5 ft	
L =	25.5 ft	

Solution:

Percent of Goal Achieved = 100.88 % = [(4.4 x 650) / 2,862] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1020.62 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #8

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **21,834** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(21,834 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(21,834 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area
Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	21,834	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	21,834	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	21,834	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	89

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.27 in	S_{POST}=	$\frac{1000}{89} - 10$
Q_{POST}=	0.03199 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.27)]^2}{[(1.00 * 1.17)+(0.8 * 1.27)]} \times \frac{1ft}{12in}$
V_{GOAL}=	698.47 ft^3	V_{GOAL}=	(0.03199)(21,834)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	21,834	ft^2 =	0.50124 Acres
C_{POST} [10] =	0.47		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.05513 cfs

$Q_{TREATMENT}$= (0.2)(0.5012)(0.47)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	21,834	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	89

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 65.72 ft^3

V_{PRE}= (0.00301)(21,834)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.27 in

$$S_{POST} = \frac{1000}{89} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02694 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.27)]^2}{[(0.92*1.17)+(0.8*1.27)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 588.21 ft^3

V_{POST}= (0.02694)(21,834)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (588.21) - (65.72)

V_{DELTA}= 522.49 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1587.43 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 324.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 698 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	5.0 ft	Below perforated pipe if present
W =	18.0 ft	
L =	18.0 ft	

Solution:

Percent of Goal Achieved = 102.05 % = [(5.0 x 324) / 1,587] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 522.49 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #9

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **8,414** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(8,414 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(8,414 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	8,414	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	8,414	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	8,414	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.85776 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04467 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.86)]^2}{[(1.00 * 1.17)+(0.8 * 0.86)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 375.85 ft^3

$V_{GOAL} = (0.04467)(8,414)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	8,414	ft^2 =	0.19316 Acres
C_{POST} [10] =	0.50		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.02260 cfs

$Q_{TREATMENT}$= (0.2)(0.1932)(0.50)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	8,414	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 25.33 ft^3

V_{PRE}= (0.00301)(8,414)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.85776 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03863 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.86)]^2}{[(0.92*1.17)+(0.8*0.86)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 325.03 ft^3

V_{POST}= (0.03863)(8,414)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (325.03) - (25.33)

V_{DELTA}= 299.71 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 854.21 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 204.49 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 376 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.2 ft	Below perforated pipe if present
W =	14.3 ft	
L =	14.3 ft	

Solution:

Percent of Goal Achieved = 100.54 % = [(4.2 x 204) / 854] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 299.71 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #10

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **39,220** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(39,220 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(39,220 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	39,220	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	39,220	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	39,220	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04216 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.93)]^2}{[(1.00 * 1.17)+(0.8 * 0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1653.52 ft^3

V_{GOAL}= (0.04216)(39,220)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	39,220	ft^2 =	0.90037 Acres
C_{POST} [10] =	0.54		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.11377 cfs

$Q_{TREATMENT}$= (0.2)(0.9004)(0.54)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	39,220	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 118.05 ft^3

V_{PRE}= (0.00301)(39,220)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03629 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.93)]^2}{[(0.92*1.17)+(0.8*0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1423.29 ft^3

V_{POST}= (0.03629)(39,220)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,423.29) - (118.05)

V_{DELTA}= 1305.24 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3757.99 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1914.06 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,654 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.0 ft	Below perforated pipe if present
W =	43.8 ft	
L =	43.8 ft	

Solution:

Percent of Goal Achieved = 101.87 % = [(2.0 x 1,914) / 3,758] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1305.24 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #11

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **14,350** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(14,350 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(14,350 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area
Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	14,350	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	14,350	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,350	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.01 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03948 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.01)]^2}{[(1.00 * 1.17)+(0.8 * 1.01)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 566.54 ft^3

V_{GOAL}= (0.03948)(14,350)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	14,350	ft^2 =	0.32943 Acres
C_{POST} [10] =	0.52		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.04009 cfs**

$Q_{TREATMENT}$= (0.2)(0.3294)(0.52)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,350	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 43.19 ft^3

V_{PRE}= (0.00301)(14,350)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.01 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03381 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.01)]^2}{[(0.92*1.17)+(0.8*1.01)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 485.17 ft^3

V_{POST}= (0.03381)(14,350)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (485.17) - (43.19)

V_{DELTA}= 441.98 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1287.59 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 338.56 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 567 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.8 ft	Below perforated pipe if present
W =	18.4 ft	
L =	18.4 ft	

Solution:

Percent of Goal Achieved = 100.97 % = [(3.8 x 339) / 1,288] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 441.98 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #12

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **26,208** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(26,208 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(26,208 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	26,208	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	26,208	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	26,208	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.88139 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04394 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.88)]^2}{[(1.00 * 1.17)+(0.8 * 0.88)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1151.58 ft^3

$V_{GOAL} = (0.04394)(26,208)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	26,208	ft^2 =	0.60165 Acres
C_{POST} [10] =	0.55		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07743 cfs

$Q_{TREATMENT}$= (0.2)(0.6017)(0.55)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	26,208	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 78.89 ft^3

V_{PRE}= (0.00301)(26,208)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.88139 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03795 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.88)]^2}{[(0.92*1.17)+(0.8*0.88)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 994.59 ft^3

V_{POST}= (0.03795)(26,208)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (994.59) - (78.89)

V_{DELTA}= 915.71 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1645.11 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 320.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,152 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.7	as a decimal
D =	5.5 ft	Below perforated pipe if present
W =	8.0 ft	
L =	40.0 ft	

Solution:

Percent of Goal Achieved = 106.98 % = [(5.5 x 320) / 1,645] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 915.71 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #13

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **19,862** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(19,862 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(19,862 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	19,862	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	19,862	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,862	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04216 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.93)]^2}{[(1.00 * 1.17)+(0.8 * 0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 837.38 ft^3

V_{GOAL}= (0.04216)(19,862)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	19,862	ft^2 =	0.45597 Acres
C_{POST} [10] =	0.54		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.05762 cfs

$Q_{TREATMENT}$= (0.2)(0.4560)(0.54)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,862	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 59.78 ft^3

V_{PRE}= (0.00301)(19,862)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03629 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.93)]^2}{[(0.92*1.17)+(0.8*0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 720.79 ft^3

V_{POST}= (0.03629)(19,862)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (720.79) - (59.78)

V_{DELTA}= 661.01 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1903.14 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 449.44 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 837 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.2 ft	Below perforated pipe if present
W =	21.2 ft	
L =	21.2 ft	

Solution:

Percent of Goal Achieved = 100.13 % = [(4.2 x 449) / 1,903] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 661.01 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #14

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **8,121** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(8,121 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(8,121 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	8,121	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	8,121	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	8,121	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	87

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.44 in	S_{POST}=	$\frac{1000}{87} - 10$
Q_{POST}=	0.02792 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.44)]^2}{[(1.00 * 1.17)+(0.8 * 1.44)]} \times \frac{1ft}{12in}$
V_{GOAL}=	226.74 ft^3	V_{GOAL}=	(0.02792)(8,121)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	8,121	ft^2 =	0.18643 Acres
C_{POST} [10] =	0.43		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.01876 cfs

$Q_{TREATMENT}$= (0.2)(0.1864)(0.43)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	8,121	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	87

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 24.44 ft^3

V_{PRE}= (0.00301)(8,121)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.44 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02324 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.44)]^2}{[(0.92*1.17)+(0.8*1.44)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 188.73 ft^3

V_{POST}= (0.02324)(8,121)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (188.73) - (24.44)

V_{DELTA}= 164.29 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 515.31 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 368.64 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 227 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.4 ft	Below perforated pipe if present
W =	19.2 ft	
L =	19.2 ft	

Solution:

Percent of Goal Achieved = 100.15 % = [(1.4 x 369) / 515] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 164.29 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

100

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #15

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **24,620** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(24,620 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(24,620 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	24,620	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	24,620	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,620	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05198 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.68)]^2}{[(1.00 * 1.17)+(0.8 * 0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1279.75 ft^3

V_{GOAL}= (0.05198)(24,620)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	24,620	ft^2 =	0.56520 Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07803 cfs

$Q_{TREATMENT}$= (0.2)(0.5652)(0.59)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,620	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 74.11 ft^3

V_{PRE}= (0.00301)(24,620)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04548 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.68)]^2}{[(0.92*1.17)+(0.8*0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1119.72 ft^3

V_{POST}= (0.04548)(24,620)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,119.72) - (74.11)

V_{DELTA}= 1045.61 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2908.52 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 948.64 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,280 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.1 ft	Below perforated pipe if present
W =	30.8 ft	
L =	30.8 ft	

Solution:

Percent of Goal Achieved = 101.11 % = [(3.1 x 949) / 2,909] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1045.61 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #16

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **24,684** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(24,684 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(24,684 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] *From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).*

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	24,684	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	24,684	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,684	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	93

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.77586 in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	0.04776 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.78)]^2}{[(1.00 * 1.17)+(0.8 * 0.78)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1178.91 ft^3	V_{GOAL}=	(0.04776)(24,684)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	24,684	ft^2 =	0.56667 Acres
C_{POST} [10] =	0.53		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07028 cfs

$Q_{TREATMENT}$= (0.2)(0.5667)(0.53)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,684	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 74.30 ft^3

V_{PRE}= (0.00301)(24,684)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.77586 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04152 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.78)]^2}{[(0.92*1.17)+(0.8*0.78)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1024.88 ft^3

V_{POST}= (0.04152)(24,684)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,024.88) - (74.30)

V_{DELTA}= 950.58 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **2679.34** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **745.29** ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = **1,179** ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.6 ft	Below perforated pipe if present
W =	27.3 ft	
L =	27.3 ft	

Solution:

Percent of Goal Achieved = **100.14** % = [(3.6 x 745) / 2,679] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **#DIV/0!** ft^3

$A_{LID\ DELTA}=(W)(L)$ = **0.00** ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= **950.58** ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = **#DIV/0!** % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #17

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **13,521** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(13,521 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(13,521 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	13,521	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	13,521	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	13,521	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	88

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.31 in	S_{POST}=	$\frac{1000}{88} - 10$
Q_{POST}=	0.03098 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.31)]^2}{[(1.00 * 1.17)+(0.8 * 1.31)]} \times \frac{1ft}{12in}$
V_{GOAL}=	418.88 ft^3	V_{GOAL}=	(0.03098)(13,521)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	13,521	ft^2 =	0.31040 Acres
C_{POST} [10] =	0.38		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.02760 cfs

$Q_{TREATMENT}$= (0.2)(0.3104)(0.38)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	13,521	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	88

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 40.70 ft^3

V_{PRE}= (0.00301)(13,521)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.31 in

$$S_{POST} = \frac{1000}{88} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02602 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.31)]^2}{[(0.92*1.17)+(0.8*1.31)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 351.82 ft^3

V_{POST}= (0.02602)(13,521)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (351.82) - (40.70)

V_{DELTA}= 311.12 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 952.00 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 620.01 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 419 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.5 ft	Below perforated pipe if present
W =	24.9 ft	
L =	24.9 ft	

Solution:

Percent of Goal Achieved = 100.30 % = [(1.5 x 620) / 952] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 311.12 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #18

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **12,302** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(12,302 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(12,302 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	12,302	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	12,302	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,302	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.01 in	S_{POST}=	$\frac{1000}{91} - 10$
Q_{POST}=	0.03948 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.01)]^2}{[(1.00 * 1.17)+(0.8 * 1.01)]} \times \frac{1ft}{12in}$
V_{GOAL}=	485.68 ft^3	V_{GOAL}=	(0.03948)(12,302)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	12,302	ft^2 =	0.28242 Acres
C_{POST} [10] =	0.46		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.03040 cfs

$Q_{TREATMENT}$= (0.2)(0.2824)(0.46)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,302	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 37.03 ft^3

V_{PRE}= (0.00301)(12,302)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.01 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03381 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.01)]^2}{[(0.92*1.17)+(0.8*1.01)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 415.93 ft^3

V_{POST}= (0.03381)(12,302)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (415.93) - (37.03)

V_{DELTA}= 378.90 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1103.82 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 420.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 486 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.6 ft	Below perforated pipe if present
W =	20.5 ft	
L =	20.5 ft	

Solution:

Percent of Goal Achieved = 100.51 % = [(2.6 x 420) / 1,104] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 378.90 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #19

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **20,821** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(20,821 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(20,821 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	20,821	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	20,821	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	20,821	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	88

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.39 in	S_{POST}=	$\frac{1000}{88} - 10$
Q_{POST}=	0.02906 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.39)]^2}{[(1.00 * 1.17)+(0.8 * 1.39)]} \times \frac{1ft}{12in}$
V_{GOAL}=	605.06 ft^3	V_{GOAL}=	(0.02906)(20,821)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	20,821	ft^2 =	0.47798 Acres
C_{POST} [10] =	0.36		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.04027 cfs**

$Q_{TREATMENT}$= (0.2)(0.4780)(0.36)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	20,821	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	88

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 62.67 ft^3

V_{PRE}= (0.00301)(20,821)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.39 in

$$S_{POST} = \frac{1000}{88} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02427 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.39)]^2}{[(0.92*1.17)+(0.8*1.39)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 505.33 ft^3

V_{POST}= (0.02427)(20,821)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (505.33) - (62.67)

V_{DELTA}= 442.65 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1375.13 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 650.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 605 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.1 ft	Below perforated pipe if present
W =	25.5 ft	
L =	25.5 ft	

Solution:

Percent of Goal Achieved = 101.19 % = [(2.1 x 650) / 1,375] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 442.65 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

130

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #20

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **15,006** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(15,006 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(15,006 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	15,006	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	15,006	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	15,006	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.01 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03948 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.01)]^2}{[(1.00 * 1.17)+(0.8 * 1.01)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 592.44 ft^3

V_{GOAL}= (0.03948)(15,006)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	15,006	ft^2 =	0.34449 Acres
C_{POST} [10] =	0.46		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.03708 cfs

$Q_{TREATMENT}$= (0.2)(0.3445)(0.46)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	15,006	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 45.17 ft^3

V_{PRE}= (0.00301)(15,006)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.01 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03381 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.01)]^2}{[(0.92*1.17)+(0.8*1.01)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 507.35 ft^3

V_{POST}= (0.03381)(15,006)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (507.35) - (45.17)

V_{DELTA}= 462.18 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1346.45 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 750.76 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 592 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.8 ft	Below perforated pipe if present
W =	27.4 ft	
L =	27.4 ft	

Solution:

Percent of Goal Achieved = 100.37 % = [(1.8 x 751) / 1,346] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 462.18 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #22

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **43,427** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(43,427 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(43,427 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	43,427	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	43,427	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,427	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	87

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.45 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02770 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.45)]^2}{[(1.00 * 1.17)+(0.8 * 1.45)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1202.93 ft^3

$V_{GOAL} = (0.02770)(43,427)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	43,427	ft^2 =	0.99695 Acres
C_{POST} [10] =	0.34		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07932 cfs

$Q_{TREATMENT}$= (0.2)(0.9969)(0.34)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,427	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	87

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 390.84 ft^3

V_{PRE}= (0.00900)(43,427)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.45 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02304 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.45)]^2}{[(0.92*1.17)+(0.8*1.45)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1000.56 ft^3

V_{POST}= (0.02304)(43,427)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,000.56) - (390.84)

V_{DELTA}= 609.72 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2733.93 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1274.49 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,203 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.2 ft	Below perforated pipe if present
W =	35.7 ft	
L =	35.7 ft	

Solution:

Percent of Goal Achieved = 102.56 % = [(2.2 x 1,274) / 2,734] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 609.72 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #22

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **43,427** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(43,427 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(43,427 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	43,427	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	43,427	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,427	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	87

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.45 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02770 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.45)]^2}{[(1.00 * 1.17)+(0.8 * 1.45)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1202.93 ft^3

$V_{GOAL} = (0.02770)(43,427)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	43,427	ft^2 =	0.99695 Acres
C_{POST} [10] =	0.34		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07932 cfs

$Q_{TREATMENT}$= (0.2)(0.9969)(0.34)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,427	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	87

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 390.84 ft^3

V_{PRE}= (0.00900)(43,427)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.45 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02304 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.45)]^2}{[(0.92*1.17)+(0.8*1.45)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1000.56 ft^3

V_{POST}= (0.02304)(43,427)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,000.56) - (390.84)

V_{DELTA}= 609.72 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2733.93 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1274.49 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,203 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.2 ft	Below perforated pipe if present
W =	35.7 ft	
L =	35.7 ft	

Solution:

Percent of Goal Achieved = 102.56 % = [(2.2 x 1,274) / 2,734] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 609.72 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #23

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **23,920** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(23,920 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(23,920 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	23,920	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	23,920	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	23,920	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	96

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.46025 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.06297 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.46)]^2}{[(1.00 * 1.17)+(0.8 * 0.46)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1506.24 ft^3

V_{GOAL}= (0.06297)(23,920)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	23,920	ft^2 =	0.54913 Acres
C_{POST} [10] =	0.62		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07967 cfs

$Q_{TREATMENT}$= (0.2)(0.5491)(0.62)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	23,920	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	96

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 215.28 ft^3

V_{PRE}= (0.00900)(23,920)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.46025 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05591 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.46)]^2}{[(0.92*1.17)+(0.8*0.46)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1337.37 ft^3

V_{POST}= (0.05591)(23,920)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,337.37) - (215.28)

V_{DELTA}= 1122.09 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3423.28 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1128.96 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,506 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.1 ft	Below perforated pipe if present
W =	33.6 ft	
L =	33.6 ft	

Solution:

Percent of Goal Achieved = 102.23 % = [(3.1 x 1,129) / 3,423] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1122.09 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #24

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **34,991** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(34,991 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(34,991 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	34,991	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	34,991	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	34,991	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	93

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.76426 in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	0.04857 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.76)]^2}{[(1.00 * 1.17)+(0.8 * 0.76)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1699.51 ft^3	V_{GOAL}=	(0.04857)(34,991)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	34,991	ft^2 =	0.80328 Acres
C_{POST} [10] =	0.53		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.09962 cfs

$Q_{TREATMENT}$= (0.2)(0.8033)(0.53)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	34,991	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 314.92 ft^3

V_{PRE}= (0.00900)(34,991)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.76426 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04228 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.76)]^2}{[(0.92*1.17)+(0.8*0.76)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1479.42 ft^3

V_{POST}= (0.04228)(34,991)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,479.42) - (314.92)

V_{DELTA}= 1164.50 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3862.53 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1369.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,700 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.8 ft	Below perforated pipe if present
W =	37.0 ft	
L =	37.0 ft	

Solution:

Percent of Goal Achieved = 100.66 % = [(2.8 x 1,369) / 3,863] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1164.50 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #25

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **33,215** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(33,215 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(33,215 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	33,215	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	33,215	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	33,215	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.04 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03852 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.04)]^2}{[(1.00 * 1.17)+(0.8 * 1.04)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1279.44 ft^3

V_{GOAL}= (0.03852)(33,215)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	33,215	ft^2 =	0.76251 Acres
C_{POST} [10] =	0.45		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.08029 cfs**

$Q_{TREATMENT}$= (0.2)(0.7625)(0.45)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	33,215	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 298.94 ft^3

V_{PRE}= (0.00900)(33,215)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.04 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03293 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.04)]^2}{[(0.92*1.17)+(0.8*1.04)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1093.77 ft^3

V_{POST}= (0.03293)(33,215)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,093.77) - (298.94)

V_{DELTA}= 794.83 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2907.82 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 702.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,279 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.1 ft	Below perforated pipe if present
W =	26.5 ft	
L =	26.5 ft	

Solution:

Percent of Goal Achieved = 99.98 % = [(4.1 x 702) / 2,908] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 794.83 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #26

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **51,446** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(51,446 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(51,446 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	51,446	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	51,446	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	51,446	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.86957 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04430 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.87)]^2}{[(1.00 * 1.17)+(0.8 * 0.87)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 2279.06 ft^3

V_{GOAL}= (0.04430)(51,446)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	51,446	ft^2 =	1.18 Acres
C_{POST} [10] =	0.50		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.13818 cfs**

$Q_{TREATMENT}$= (0.2)(1.18)(0.50)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	51,446	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 463.01 ft^3

V_{PRE}= (0.00900)(51,446)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.86957 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03829 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.87)]^2}{[(0.92*1.17)+(0.8*0.87)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1969.87 ft^3

V_{POST}= (0.03829)(51,446)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,969.87) - (463.01)

V_{DELTA}= 1506.85 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 5179.68 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1036.84 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 2,279 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	5.0 ft	Below perforated pipe if present
W =	32.2 ft	
L =	32.2 ft	

Solution:

Percent of Goal Achieved = 100.09 % = [(5.0 x 1,037) / 5,180] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1506.85 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #27

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **39,558** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(39,558 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(39,558 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	39,558	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	39,558	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	39,558	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.05 in	S_{POST}=	$\frac{1000}{91} - 10$
Q_{POST}=	0.03821 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.05)]^2}{[(1.00 * 1.17)+(0.8 * 1.05)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1511.51 ft^3	V_{GOAL}=	(0.03821)(39,558)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	39,558	ft^2 =	0.90813 Acres
C_{POST} [10] =	0.45		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.09563 cfs**

$Q_{TREATMENT}$= (0.2)(0.9081)(0.45)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	39,558	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 356.02 ft^3

V_{PRE}= (0.00900)(39,558)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.05 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03264 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.05)]^2}{[(0.92*1.17)+(0.8*1.05)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1291.17 ft^3

V_{POST}= (0.03264)(39,558)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,291.17) - (356.02)

V_{DELTA}= 935.15 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3435.25 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 973.44 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,512 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.5 ft	Below perforated pipe if present
W =	31.2 ft	
L =	31.2 ft	

Solution:

Percent of Goal Achieved = 100.31 % = [(3.5 x 973) / 3,435] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 935.15 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #28

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **33,681** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(33,681 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(33,681 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	33,681	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	33,681	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	33,681	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	89

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.20 in

$$S_{POST} = \frac{1000}{89} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03384 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.20)]^2}{[(1.00 * 1.17)+(0.8 * 1.20)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1139.77 ft^3

$V_{GOAL} = (0.03384)(33,681)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	33,681	ft^2 =	0.77321 Acres
C_{POST} [10] =	0.41		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07418 cfs

$Q_{TREATMENT}$= (0.2)(0.7732)(0.41)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	33,681	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	89

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 303.13 ft^3

V_{PRE}= (0.00900)(33,681)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.20 in

$$S_{POST} = \frac{1000}{89} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02863 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.20)]^2}{[(0.92*1.17)+(0.8*1.20)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 964.29 ft^3

V_{POST}= (0.02863)(33,681)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (964.29) - (303.13)

V_{DELTA}= 661.16 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2590.38 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 650.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,140 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.0 ft	Below perforated pipe if present
W =	25.5 ft	
L =	25.5 ft	

Solution:

Percent of Goal Achieved = 100.41 % = [(4.0 x 650) / 2,590] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 661.16 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #29

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **22,085** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(22,085 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(22,085 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	22,085	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	22,085	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,085	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	96

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.41667 in	S_{POST}=	$\frac{1000}{96} - 10$
Q_{POST}=	0.06526 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.42)]^2}{[(1.00 * 1.17)+(0.8 * 0.42)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1441.27 ft^3	V_{GOAL}=	(0.06526)(22,085)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	22,085 ft^2	=	0.50700 Acres
C_{POST} [10] =	0.63		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07474 cfs

$Q_{TREATMENT}$= (0.2)(0.5070)(0.63)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,085	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	96

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 198.77 ft^3

V_{PRE}= (0.00900)(22,085)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.41667 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05811 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.42)]^2}{[(0.92*1.17)+(0.8*0.42)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1283.36 ft^3

V_{POST}= (0.05811)(22,085)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,283.36) - (198.77)

V_{DELTA}= 1084.59 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3275.61 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 750.76 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,441 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.4 ft	Below perforated pipe if present
W =	27.4 ft	
L =	27.4 ft	

Solution:

Percent of Goal Achieved = 100.85 % = [(4.4 x 751) / 3,276] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1084.59 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #30

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **25,456** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(25,456 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(25,456 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	**25,456**	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	**0.00**	ft^2
Reduced Tributary Area to be used for Calculations =	**25,456**	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	**25,456**	ft^2
K [7] =	**1.17**	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	**C: 0.05 - 0.15 in/hr infiltration (transmission) rate**
Select post development ground cover description [5] =	**Impervious - Paved Parking, Rooftop, Driveways**

CN_{POST} =	**98**	
OR: Composite post development CN [9] =	**94**	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	**0.68376** in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	**0.05198** ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.68)]^2}{[(1.00 * 1.17)+(0.8 * 0.68)]} \times \frac{1ft}{12in}$
V_{GOAL}=	**1323.20** ft^3	V_{GOAL}=	(0.05198)(25,456)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	25,456	ft^2 =	0.58439 Acres
C_{POST} [10] =	0.55		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07521 cfs

$Q_{TREATMENT}$= (0.2)(0.5844)(0.55)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	25,456	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 229.10 ft^3

V_{PRE}= (0.00900)(25,456)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04548 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.68)]^2}{[(0.92*1.17)+(0.8*0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1157.74 ft^3

V_{POST}= (0.04548)(25,456)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,157.74) - (229.10)

V_{DELTA}= 928.63 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3007.28 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 761.76 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,323 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.0 ft	Below perforated pipe if present
W =	27.6 ft	
L =	27.6 ft	

Solution:

Percent of Goal Achieved = 101.32 % = [(4.0 x 762) / 3,007] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 928.63 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #31

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **14,563** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(14,563 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(14,563 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	14,563	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	14,563	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,563	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	93

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.72961 in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	0.04982 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.73)]^2}{[(1.00 * 1.17)+(0.8 * 0.73)]} \times \frac{1ft}{12in}$
V_{GOAL}=	725.53 ft^3	V_{GOAL}=	(0.04982)(14,563)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	14,563 ft^2 =	0.33432	Acres
C_{POST} [10] =	0.54		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.04224 cfs

$Q_{TREATMENT}$= (0.2)(0.3343)(0.54)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,563	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 131.07 ft^3

V_{PRE}= (0.00900)(14,563)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.72961 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04345 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.73)]^2}{[(0.92*1.17)+(0.8*0.73)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 632.76 ft^3

V_{POST}= (0.04345)(14,563)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (632.76) - (131.07)

V_{DELTA}= 501.70 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1648.93 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 441.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 726 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.8 ft	Below perforated pipe if present
W =	21.0 ft	
L =	21.0 ft	

Solution:

Percent of Goal Achieved = 101.63 % = [(3.8 x 441) / 1,649] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 501.70 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #32

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **7,361** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(7,361 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(7,361 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	7,361	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	7,361	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	7,361	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	95

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.57082 in	S_{POST}=	$\frac{1000}{95} - 10$
Q_{POST}=	0.05715 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.57)]^2}{[(1.00 * 1.17)+(0.8 * 0.57)]} \times \frac{1ft}{12in}$
V_{GOAL}=	420.68 ft^3	V_{GOAL}=	(0.05715)(7,361)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

Input:

A_r =	7,361	ft^2 =	0.16899 Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.02333 cfs

$Q_{TREATMENT}$= (0.2)(0.1690)(0.59)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	7,361	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	95

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 66.25 ft^3

V_{PRE}= (0.00900)(7,361)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.57082 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05037 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.57)]^2}{[(0.92*1.17)+(0.8*0.57)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 370.77 ft^3

V_{POST}= (0.05037)(7,361)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (370.77) - (66.25)

V_{DELTA}= 304.52 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

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LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 956.09 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 549.90 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 421 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.7 ft	Below perforated pipe if present
W =	23.5 ft	
L =	23.5 ft	

Solution:

Percent of Goal Achieved = 100.08 % = [(1.7 x 550) / 956] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 304.52 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #33

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **7,412** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(7,412 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(7,412 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	7,412	ft²
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft²
Reduced Tributary Area to be used for Calculations =	7,412	ft²

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	7,412	ft²
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways

CN_{POST} =	98	
OR: Composite post development CN [9] =	94	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.66098 in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	0.05288 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.66)]^2}{[(1.00 * 1.17)+(0.8 * 0.66)]} \times \frac{1ft}{12in}$
V_{GOAL}=	391.95 ft³	V_{GOAL}=	(0.05288)(7,412)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	7,412	ft^2 =	0.17016 Acres
C_{POST} [10] =	0.63		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.02508 cfs

$Q_{TREATMENT}$= (0.2)(0.1702)(0.63)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	7,412	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 66.71 ft^3

V_{PRE}= (0.00900)(7,412)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.66098 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04633 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.66)]^2}{[(0.92*1.17)+(0.8*0.66)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 343.40 ft^3

V_{POST}= (0.04633)(7,412)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (343.40) - (66.71)

V_{DELTA}= 276.69 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

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LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 890.79 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 488.41 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 392 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.9 ft	Below perforated pipe if present
W =	22.1 ft	
L =	22.1 ft	

Solution:

Percent of Goal Achieved = 104.18 % = [(1.9 x 488) / 891] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 276.69 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #34

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **30,425** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(30,425 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(30,425 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	30,425	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	30,425	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	30,425	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	95

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.48218 in	S_{POST}=	$\frac{1000}{95} - 10$
Q_{POST}=	0.06186 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.48)]^2}{[(1.00 * 1.17)+(0.8 * 0.48)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1882.09 ft^3	V_{GOAL}=	(0.06186)(30,425)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	30,425	ft^2 =	0.69846 Acres
C_{POST} [10] =	0.61		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.09970 cfs

$Q_{TREATMENT}$= (0.2)(0.6985)(0.61)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	30,425	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	95

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 273.83 ft^3

V_{PRE}= (0.00900)(30,425)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.48218 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05485 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.48)]^2}{[(0.92*1.17)+(0.8*0.48)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1668.81 ft^3

V_{POST}= (0.05485)(30,425)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,668.81) - (273.83)

V_{DELTA}= 1394.99 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 4277.48 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1544.49 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,882 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.8 ft	Below perforated pipe if present
W =	39.3 ft	
L =	39.3 ft	

Solution:

Percent of Goal Achieved = 101.10 % = [(2.8 x 1,544) / 4,277] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1394.99 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #35

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **44,444** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(44,444 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(44,444 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	44,444	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	44,444	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	44,444	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	95

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.54852 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05816 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.55)]^2}{[(1.00 * 1.17)+(0.8 * 0.55)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 2584.86 ft^3

$$V_{GOAL} = (0.05816)(44,444)$$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	44,444	ft^2 =	1.02 Acres
C_{POST} [10] =	0.60		
K [7] =	1.2		

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Solution:

$Q_{TREATMENT}$= 0.14325 cfs

$Q_{TREATMENT}$= (0.2)(1.02)(0.60)(1.17)

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	44,444	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	95

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 400.00 ft^3

V_{PRE}= (0.00900)(44,444)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.54852 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05132 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.55)]^2}{[(0.92*1.17)+(0.8*0.55)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 2280.87 ft^3

V_{POST}= (0.05132)(44,444)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (2,280.87) - (400.00)

V_{DELTA}= 1880.87 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 5874.69 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 2787.84 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 2,585 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.1 ft	Below perforated pipe if present
W =	52.8 ft	
L =	52.8 ft	

Solution:

Percent of Goal Achieved = 101.55 % = [(2.1 x 2,788) / 5,875] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1880.87 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #36

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **45,015** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(45,015 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(45,015 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	45,015	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	45,015	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	45,015	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	93

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.77586 in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	0.04776 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.78)]^2}{[(1.00 * 1.17)+(0.8 * 0.78)]} \times \frac{1ft}{12in}$
V_{GOAL}=	2149.92 ft^3	V_{GOAL}=	(0.04776)(45,015)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	45,015 ft^2 =	1.03	Acres
C_{POST} [10] =	0.53		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.12816 cfs

$Q_{TREATMENT}$= (0.2)(1.03)(0.53)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	45,015	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 405.14 ft^3

V_{PRE}= (0.00900)(45,015)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.77586 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04152 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.78)]^2}{[(0.92*1.17)+(0.8*0.78)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1869.02 ft^3

V_{POST}= (0.04152)(45,015)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,869.02) - (405.14)

V_{DELTA}= 1463.89 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 4886.17 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 2116.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 2,150 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.3 ft	Below perforated pipe if present
W =	46.0 ft	
L =	46.0 ft	

Solution:

Percent of Goal Achieved = 101.34 % = [(2.3 x 2,116) / 4,886] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1463.89 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #37

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **24,028** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(24,028 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(24,028 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	24,028	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	24,028	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,028	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.66098 in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	0.05288 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.66)]^2}{[(1.00 * 1.17)+(0.8 * 0.66)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1270.60 ft^3	V_{GOAL}=	(0.05288)(24,028)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	24,028	ft^2 =	0.55161 Acres
C_{POST} [10] =	0.56		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07228 cfs

$Q_{TREATMENT}$= (0.2)(0.5516)(0.56)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,028	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 216.25 ft^3

V_{PRE}= (0.00900)(24,028)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.66098 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04633 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.66)]^2}{[(0.92*1.17)+(0.8*0.66)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1113.22 ft^3

V_{POST}= (0.04633)(24,028)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,113.22) - (216.25)

V_{DELTA}= 896.97 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2887.73 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1099.59 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,271 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.6 ft	Below perforated pipe if present
W =	33.2 ft	
L =	33.2 ft	

Solution:

Percent of Goal Achieved = 100.53 % = [(2.6 x 1,100) / 2,888] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 896.97 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #38

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **22,242** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(22,242 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(22,242 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	22,242	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	22,242	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,242	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways

CN_{POST} =	98	
OR: Composite post development CN [9] =	98	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.20408 in	S_{POST}=	$\frac{1000}{98} - 10$
Q_{POST}=	0.08001 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.20)]^2}{[(1.00 * 1.17)+(0.8 * 0.20)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1779.58 ft^3	V_{GOAL}=	(0.08001)(22,242)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	22,242	ft^2 =	0.51061 Acres
C_{POST} [10] =	0.70		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.08364 cfs

$Q_{TREATMENT}$= (0.2)(0.5106)(0.70)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,242	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	98

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 200.18 ft^3

V_{PRE}= (0.00900)(22,242)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.07240 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.20)]^2}{[(0.92*1.17)+(0.8*0.20)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1610.32 ft^3

V_{POST}= (0.07240)(22,242)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,610.32) - (200.18)

V_{DELTA}= 1410.14 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 4044.51 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1449.32 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,780 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.8 ft	Below perforated pipe if present
W =	38.1 ft	
L =	38.1 ft	

Solution:

Percent of Goal Achieved = 100.34 % = [(2.8 x 1,449) / 4,045] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1410.14 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #39

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **6,898** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(6,898 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(6,898 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	6,898	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	6,898	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	6,898	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	98

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.20408 in	S_{POST}=	$\frac{1000}{98} - 10$
Q_{POST}=	0.08001 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.20)]^2}{[(1.00 * 1.17)+(0.8 * 0.20)]} \times \frac{1ft}{12in}$
V_{GOAL}=	551.91 ft^3	V_{GOAL}=	(0.08001)(6,898)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	6,898 ft^2 =	0.15836	Acres
C_{POST} [10] =	0.70		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.02594 cfs

$Q_{TREATMENT}$= (0.2)(0.1584)(0.70)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	6,898	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	98

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 62.08 ft^3

V_{PRE}= (0.00900)(6,898)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.07240 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.20)]^2}{[(0.92*1.17)+(0.8*0.20)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 499.42 ft^3

V_{POST}= (0.07240)(6,898)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (499.42) - (62.08)

V_{DELTA}= 437.33 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1254.34 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 540.10 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 552 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.3 ft	Below perforated pipe if present
W =	23.2 ft	
L =	23.2 ft	

Solution:

Percent of Goal Achieved = 100.76 % = [(2.3 x 540) / 1,254] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 437.33 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #40

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **35,086** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(35,086 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(35,086 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	35,086	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	35,086	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	35,086	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	95

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.57082 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05715 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.57)]^2}{[(1.00 * 1.17)+(0.8 * 0.57)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 2005.16 ft^3

V_{GOAL}= (0.05715)(35,086)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	35,086	ft^2 =	0.80546 Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.11120 cfs

$Q_{TREATMENT}$= (0.2)(0.8055)(0.59)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	35,086	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	95

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 315.77 ft^3

V_{PRE}= (0.00900)(35,086)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.57082 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05037 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.57)]^2}{[(0.92*1.17)+(0.8*0.57)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1767.28 ft^3

V_{POST}= (0.05037)(35,086)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,767.28) - (315.77)

V_{DELTA}= 1451.51 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2864.52 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 528.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 2,005 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.7	as a decimal
D =	5.5 ft	Below perforated pipe if present
W =	8.0 ft	
L =	66.0 ft	

Solution:

Percent of Goal Achieved = 101.38 % = [(5.5 x 528) / 2,865] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1451.51 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #41

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **43,274** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(43,274 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(43,274 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	43,274	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	43,274	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,274	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.92896 in	S_{POST}=	$\frac{1000}{92} - 10$
Q_{POST}=	0.04216 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.93)]^2}{[(1.00 * 1.17)+(0.8 * 0.93)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1824.43 ft^3	V_{GOAL}=	(0.04216)(43,274)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	43,274	ft^2 =	0.99343 Acres
C_{POST} [10] =	0.60		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.13948 cfs

$Q_{TREATMENT}$= (0.2)(0.9934)(0.60)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,274	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 389.47 ft^3

V_{PRE}= (0.00900)(43,274)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03629 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.93)]^2}{[(0.92*1.17)+(0.8*0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1570.41 ft^3

V_{POST}= (0.03629)(43,274)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,570.41) - (389.47)

V_{DELTA}= 1180.95 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 4146.44 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1672.81 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,824 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.5 ft	Below perforated pipe if present
W =	40.9 ft	
L =	40.9 ft	

Solution:

Percent of Goal Achieved = 100.86 % = [(2.5 x 1,673) / 4,146] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1180.95 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #42

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **19,141** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(19,141 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(19,141 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	19,141	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	19,141	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,141	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	78

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	2.87 in	S_{POST}=	$\frac{1000}{78} - 10$
Q_{POST}=	0.00854 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 2.87)]^2}{[(1.00 * 1.17)+(0.8 * 2.87)]} \times \frac{1ft}{12in}$
V_{GOAL}=	163.46 ft^3	V_{GOAL}=	(0.00854)(19,141)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	19,141	ft^2 =	0.43942 Acres
C_{POST} [10] =	0.37		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.03804 cfs

$Q_{TREATMENT}$= (0.2)(0.4394)(0.37)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,141	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	78

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 172.27 ft^3

V_{PRE}= (0.00900)(19,141)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 2.87 in

$$S_{POST} = \frac{1000}{78} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.00624 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*2.87)]^2}{[(0.92*1.17)+(0.8*2.87)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 119.44 ft^3

V_{POST}= (0.00624)(19,141)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (119.44) - (172.27)

V_{DELTA}= -52.82916 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 371.51 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 670.81 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 163 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.0 ft	Below perforated pipe if present
W =	25.9 ft	
L =	25.9 ft	

Solution:

Percent of Goal Achieved = 180.56 % = [(1.0 x 671) / 372] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= -52.82916 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #43

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **12,492** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(12,492 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(12,492 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	12,492	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	12,492	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,492	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.98901 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04013 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.99)]^2}{[(1.00 * 1.17)+(0.8 * 0.99)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 501.30 ft^3

V_{GOAL}= (0.04013)(12,492)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	12,492	ft^2 =	0.28678 Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.03959 cfs

$Q_{TREATMENT}$= (0.2)(0.2868)(0.59)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,492	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 112.43 ft^3

V_{PRE}= (0.00900)(12,492)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.98901 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03441 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.99)]^2}{[(0.92*1.17)+(0.8*0.99)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 429.85 ft^3

V_{POST}= (0.03441)(12,492)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (429.85) - (112.43)

V_{DELTA}= 317.42 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1139.33 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 338.56 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 501 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.4 ft	Below perforated pipe if present
W =	18.4 ft	
L =	18.4 ft	

Solution:

Percent of Goal Achieved = 101.03 % = [(3.4 x 339) / 1,139] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 317.42 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #44

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **27,597** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(27,597 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(27,597 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] *From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).*

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	27,597	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	27,597	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	27,597	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.69519 in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	0.05110 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.70)]^2}{[(1.00 * 1.17)+(0.8 * 0.70)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1410.21 ft^3	V_{GOAL}=	(0.05110)(27,597)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

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INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	27,597	ft^2 =	0.63354 Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.08747 cfs

$Q_{TREATMENT}$= (0.2)(0.6335)(0.59)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	27,597	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 248.37 ft^3

V_{PRE}= (0.00900)(27,597)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.69519 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04465 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.70)]^2}{[(0.92*1.17)+(0.8*0.70)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1232.21 ft^3

V_{POST}= (0.04465)(27,597)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,232.21) - (248.37)

V_{DELTA}= 983.83 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2014.58 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 368.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,410 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.7	as a decimal
D =	5.5 ft	Below perforated pipe if present
W =	8.0 ft	
L =	46.0 ft	

Solution:

Percent of Goal Achieved = 100.47 % = [(5.5 x 368) / 2,015] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 983.83 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #45

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **18,988** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(18,988 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(18,988 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	18,988	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	18,988	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	18,988	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.84599 in	S_{POST}=	$\frac{1000}{92} - 10$
Q_{POST}=	0.04505 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.85)]^2}{[(1.00 * 1.17)+(0.8 * 0.85)]} \times \frac{1ft}{12in}$
V_{GOAL}=	855.41 ft^3	V_{GOAL}=	(0.04505)(18,988)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	18,988	ft^2 =	0.43590 Acres
C_{POST} [10] =	0.56		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.05712 cfs

$Q_{TREATMENT}$= (0.2)(0.4359)(0.56)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	18,988	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 170.89 ft^3

V_{PRE}= (0.00900)(18,988)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.84599 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03898 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.85)]^2}{[(0.92*1.17)+(0.8*0.85)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 740.15 ft^3

V_{POST}= (0.03898)(18,988)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (740.15) - (170.89)

V_{DELTA}= 569.26 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1944.11 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 547.56 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 855 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.6 ft	Below perforated pipe if present
W =	23.4 ft	
L =	23.4 ft	

Solution:

Percent of Goal Achieved = 101.39 % = [(3.6 x 548) / 1,944] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 569.26 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #46

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **24,447** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(24,447 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(24,447 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	24,447	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	24,447	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,447	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.83424 in	S_{POST}=	$\frac{1000}{92} - 10$
Q_{POST}=	0.04580 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.83)]^2}{[(1.00 * 1.17)+(0.8 * 0.83)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1119.67 ft^3	V_{GOAL}=	(0.04580)(24,447)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	24,447 ft^2 =	0.56123	Acres
C_{POST} [10] =	0.61		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.08011 cfs

$Q_{TREATMENT}$= (0.2)(0.5612)(0.61)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,447	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 220.02 ft^3

V_{PRE}= (0.00900)(24,447)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.83424 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03969 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.83)]^2}{[(0.92*1.17)+(0.8*0.83)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 970.30 ft^3

V_{POST}= (0.03969)(24,447)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (970.30) - (220.02)

V_{DELTA}= 750.28 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2544.71 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 696.96 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,120 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.7 ft	Below perforated pipe if present
W =	26.4 ft	
L =	26.4 ft	

Solution:

Percent of Goal Achieved = 101.34 % = [(3.7 x 697) / 2,545] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 750.28 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #47

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **14,334** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(14,334 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(14,334 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	14,334	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	14,334	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,334	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	86

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.68 in	S_{POST}=	$\frac{1000}{86} - 10$
Q_{POST}=	0.02306 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.68)]^2}{[(1.00 * 1.17)+(0.8 * 1.68)]} \times \frac{1ft}{12in}$
V_{GOAL}=	330.54 ft^3	V_{GOAL}=	(0.02306)(14,334)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	14,334	ft^2 =	0.32906 Acres
C_{POST} [10] =	0.50		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.03850 cfs

$Q_{TREATMENT}$= (0.2)(0.3291)(0.50)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,334	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	86

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 129.01 ft^3

V_{PRE}= (0.00900)(14,334)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.68 in

$$S_{POST} = \frac{1000}{86} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.01887 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.68)]^2}{[(0.92*1.17)+(0.8*1.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 270.48 ft^3

V_{POST}= (0.01887)(14,334)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (270.48) - (129.01)

V_{DELTA}= 141.48 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 751.23 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 249.64 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 331 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.0 ft	Below perforated pipe if present
W =	15.8 ft	
L =	15.8 ft	

Solution:

Percent of Goal Achieved = 101.02 % = [(3.0 x 250) / 751] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 141.48 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #48

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **19,963** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(19,963 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(19,963 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	19,963	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	19,963	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,963	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.84599 in	S_{POST}=	$\frac{1000}{92} - 10$
Q_{POST}=	0.04505 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.85)]^2}{[(1.00 * 1.17)+(0.8 * 0.85)]} \times \frac{1ft}{12in}$
V_{GOAL}=	899.33 ft^3	V_{GOAL}=	(0.04505)(19,963)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	19,963	ft^2 =	0.45829 Acres
C_{POST} [10] =	0.56		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.06005 cfs

$Q_{TREATMENT}$= (0.2)(0.4583)(0.56)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,963	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 179.67 ft^3

V_{PRE}= (0.00900)(19,963)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.84599 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03898 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.85)]^2}{[(0.92*1.17)+(0.8*0.85)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 778.16 ft^3

V_{POST}= (0.03898)(19,963)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (778.16) - (179.67)

V_{DELTA}= 598.49 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2043.94 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 718.24 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 899 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.9 ft	Below perforated pipe if present
W =	26.8 ft	
L =	26.8 ft	

Solution:

Percent of Goal Achieved = 101.91 % = [(2.9 x 718) / 2,044] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 598.49 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #49

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **4,087** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(4,087 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(4,087 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	4,087	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	4,087	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	4,087	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.84599 in	S_{POST}=	$\frac{1000}{92} - 10$
Q_{POST}=	0.04505 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.85)]^2}{[(1.00 * 1.17)+(0.8 * 0.85)]} \times \frac{1ft}{12in}$
V_{GOAL}=	184.12 ft^3	V_{GOAL}=	(0.04505)(4,087)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	4,087	ft^2 =	0.09382 Acres
C_{POST} [10] =	0.56		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.01229 cfs

$Q_{TREATMENT}$= (0.2)(0.0938)(0.56)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	4,087	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 36.78 ft^3

V_{PRE}= (0.00900)(4,087)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.84599 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03898 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.85)]^2}{[(0.92*1.17)+(0.8*0.85)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 159.31 ft^3

V_{POST}= (0.03898)(4,087)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (159.31) - (36.78)

V_{DELTA}= 122.53 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 263.03 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 48.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 184 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.7	as a decimal
D =	5.5 ft	Below perforated pipe if present
W =	4.0 ft	
L =	12.0 ft	

Solution:

Percent of Goal Achieved = 100.37 % = [(5.5 x 48) / 263] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 122.53 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #50

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **46,173** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(46,173 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(46,173 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	46,173	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	46,173	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	46,173	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	95

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.58201 in	S_{POST}=	$\frac{1000}{95} - 10$
Q_{POST}=	0.05666 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.58)]^2}{[(1.00 * 1.17)+(0.8 * 0.58)]} \times \frac{1ft}{12in}$
V_{GOAL}=	2616.16 ft^3	V_{GOAL}=	(0.05666)(46,173)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

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Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	46,173	ft^2 =	1.06 Acres
C_{POST} [10] =	0.61		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.15130 cfs

$Q_{TREATMENT}$= (0.2)(1.06)(0.61)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	46,173	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	95

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 415.56 ft^3

V_{PRE}= (0.00900)(46,173)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.58201 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04990 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.58)]^2}{[(0.92*1.17)+(0.8*0.58)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 2304.03 ft^3

V_{POST}= (0.04990)(46,173)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (2,304.03) - (415.56)

V_{DELTA}= 1888.48 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3737.37 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 680.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 2,616 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.7	as a decimal
D =	5.5 ft	Below perforated pipe if present
W =	10.0 ft	
L =	68.0 ft	

Solution:

Percent of Goal Achieved = 100.07 % = [(5.5 x 680) / 3,737] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1888.48 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #51

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **11,547** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(11,547 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(11,547 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	11,547	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	11,547	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	11,547	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.85776 in	S_{POST}=	$\frac{1000}{92} - 10$
Q_{POST}=	0.04467 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.86)]^2}{[(1.00 * 1.17)+(0.8 * 0.86)]} \times \frac{1ft}{12in}$
V_{GOAL}=	515.80 ft^3	V_{GOAL}=	(0.04467)(11,547)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	11,547	ft^2 =	0.26508 Acres
C_{POST} [10] =	0.50		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.03101 cfs

$Q_{TREATMENT}$= (0.2)(0.2651)(0.50)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

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Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	11,547	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 103.92 ft^3

V_{PRE}= (0.00900)(11,547)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.85776 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03863 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.86)]^2}{[(0.92*1.17)+(0.8*0.86)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 446.06 ft^3

V_{POST}= (0.03863)(11,547)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (446.06) - (103.92)

V_{DELTA}= 342.14 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1172.28 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 600.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 516 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.0 ft	Below perforated pipe if present
W =	24.5 ft	
L =	24.5 ft	

Solution:

Percent of Goal Achieved = 102.41 % = [(2.0 x 600) / 1,172] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 342.14 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #52

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **21,864** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(21,864 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(21,864 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	21,864	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	21,864	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	21,864	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.68376 in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	0.05198 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.68)]^2}{[(1.00 * 1.17)+(0.8 * 0.68)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1136.49 ft^3	V_{GOAL}=	(0.05198)(21,864)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	21,864	ft^2 =	0.50193 Acres
C_{POST} [10] =	0.55		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.06460 cfs

$Q_{TREATMENT}$= (0.2)(0.5019)(0.55)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	21,864	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 196.78 ft^3

V_{PRE}= (0.00900)(21,864)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04548 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.68)]^2}{[(0.92*1.17)+(0.8*0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 994.37 ft^3

V_{POST}= (0.04548)(21,864)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (994.37) - (196.78)

V_{DELTA}= 797.60 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

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LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2582.93 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 750.76 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,136 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.4 ft	Below perforated pipe if present
W =	27.4 ft	
L =	27.4 ft	

Solution:

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Percent of Goal Achieved = 99.99 % = [(3.4 x 751) / 2,583] x 100

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 797.60 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

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Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #53

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **30,741** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(30,741 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(30,741 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	30,741	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	30,741	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	30,741	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	98

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.08001 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.20)]^2}{[(1.00 * 1.17)+(0.8 * 0.20)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 2459.59 ft^3

V_{GOAL}= (0.08001)(30,741)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	30,741 ft^2	=	0.70572 Acres
C_{POST} [10] =	0.70		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.11560 cfs

$Q_{TREATMENT}$= (0.2)(0.7057)(0.70)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	30,741	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	98

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 276.67 ft^3

V_{PRE}= (0.00900)(30,741)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.07240 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.20)]^2}{[(0.92*1.17)+(0.8*0.20)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 2225.65 ft^3

V_{POST}= (0.07240)(30,741)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (2,225.65) - (276.67)

V_{DELTA}= 1948.98 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 5589.97 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1398.76 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 2,460 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.0 ft	Below perforated pipe if present
W =	37.4 ft	
L =	37.4 ft	

Solution:

Percent of Goal Achieved = 100.09 % = [(4.0 x 1,399) / 5,590] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1948.98 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #54

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **17,291** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(17,291 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(17,291 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	17,291	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	17,291	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	17,291	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.83424 in	S_{POST}=	$\frac{1000}{92} - 10$
Q_{POST}=	0.04580 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.83)]^2}{[(1.00 * 1.17)+(0.8 * 0.83)]} \times \frac{1ft}{12in}$
V_{GOAL}=	791.93 ft^3	V_{GOAL}=	(0.04580)(17,291)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	17,291	ft^2 =	0.39695 Acres
C_{POST} [10] =	0.61		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.05666 cfs

$Q_{TREATMENT}$= (0.2)(0.3969)(0.61)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	17,291	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 155.62 ft^3

V_{PRE}= (0.00900)(17,291)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.83424 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03969 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.83)]^2}{[(0.92*1.17)+(0.8*0.83)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 686.28 ft^3

V_{POST}= (0.03969)(17,291)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (686.28) - (155.62)

V_{DELTA}= 530.66 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1799.84 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 739.84 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 792 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.4 ft	Below perforated pipe if present
W =	27.2 ft	
L =	27.2 ft	

Solution:

Percent of Goal Achieved = 100.30 % = [(2.4 x 740) / 1,800] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 530.66 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #55

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **23,221** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(23,221 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(23,221 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	23,221	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	23,221	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	23,221	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	87

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.52 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02619 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.52)]^2}{[(1.00 * 1.17)+(0.8 * 1.52)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 608.16 ft^3

$V_{GOAL} = (0.02619)(23,221)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	23,221	ft^2 =	0.53308 Acres
C_{POST} [10] =	0.52		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.06487 cfs

$Q_{TREATMENT}$= (0.2)(0.5331)(0.52)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	23,221	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	87

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 208.99 ft^3

V_{PRE}= (0.00900)(23,221)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.52 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02169 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.52)]^2}{[(0.92*1.17)+(0.8*1.52)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 503.66 ft^3

V_{POST}= (0.02169)(23,221)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

345

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (503.66) - (208.99)

V_{DELTA}= 294.67 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1382.18 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 778.41 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 608 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.8 ft	Below perforated pipe if present
W =	27.9 ft	
L =	27.9 ft	

Solution:

Percent of Goal Achieved = 101.37 % = [(1.8 x 778) / 1,382] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 294.67 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #56

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **21,403** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(21,403 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(21,403 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	21,403	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	21,403	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	21,403	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	95

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.49318 in	S_{POST}=	$\frac{1000}{95} - 10$
Q_{POST}=	0.06131 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.49)]^2}{[(1.00 * 1.17)+(0.8 * 0.49)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1312.22 ft^3	V_{GOAL}=	(0.06131)(21,403)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	21,403	ft^2 =	0.49135 Acres
C_{POST} [10] =	0.66		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07588 cfs

$Q_{TREATMENT}$= (0.2)(0.4913)(0.66)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	21,403	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	95

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 192.63 ft^3

V_{PRE}= (0.00900)(21,403)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.49318 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05433 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.49)]^2}{[(0.92*1.17)+(0.8*0.49)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1162.82 ft^3

V_{POST}= (0.05433)(21,403)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,162.82) - (192.63)

V_{DELTA}= 970.20 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2982.31 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 800.89 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,312 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.7 ft	Below perforated pipe if present
W =	28.3 ft	
L =	28.3 ft	

Solution:

Percent of Goal Achieved = 100.44 % = [(3.7 x 801) / 2,982] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 970.20 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #57

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **19,564** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(19,564 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(19,564 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	19,564	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	19,564	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,564	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	89

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.28 in	S_{POST}=	$\frac{1000}{89} - 10$
Q_{POST}=	0.03173 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.28)]^2}{[(1.00 * 1.17)+(0.8 * 1.28)]} \times \frac{1ft}{12in}$
V_{GOAL}=	620.77 ft^3	V_{GOAL}=	(0.03173)(19,564)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	19,564	ft^2 =	0.44913 Acres
C_{POST} [10] =	0.47		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.04940 cfs

$Q_{TREATMENT}$= (0.2)(0.4491)(0.47)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,564	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	89

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 176.08 ft^3

V_{PRE}= (0.00900)(19,564)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.27 in

$$S_{POST} = \frac{1000}{89} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02694 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.27)]^2}{[(0.92*1.17)+(0.8*1.27)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 527.05 ft^3

V_{POST}= (0.02694)(19,564)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (527.05) - (176.08)

V_{DELTA}= 350.98 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1410.83 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1089.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 621 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.3 ft	Below perforated pipe if present
W =	33.0 ft	
L =	33.0 ft	

Solution:

Percent of Goal Achieved = 100.35 % = [(1.3 x 1,089) / 1,411] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 350.98 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #58

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **28,421** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(28,421 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(28,421 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	28,421	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	28,421	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	28,421	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways

CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.60445 in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	0.05568 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.60)]^2}{[(1.00 * 1.17)+(0.8 * 0.60)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1582.48 ft^3	V_{GOAL}=	(0.05568)(28,421)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	28,421	ft^2 =	0.65246 Acres
C_{POST} [10] =	0.61		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.09313 cfs

$Q_{TREATMENT}$= (0.2)(0.6525)(0.61)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	28,421	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 255.79 ft^3

V_{PRE}= (0.00900)(28,421)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.60445 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04898 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.60)]^2}{[(0.92*1.17)+(0.8*0.60)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1392.06 ft^3

V_{POST}= (0.04898)(28,421)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,392.06) - (255.79)

V_{DELTA}= 1136.27 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3596.55 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1075.84 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,582 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.4 ft	Below perforated pipe if present
W =	32.8 ft	
L =	32.8 ft	

Solution:

Percent of Goal Achieved = 101.70 % = [(3.4 x 1,076) / 3,597] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1136.27 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #59

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **6,611** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(6,611 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(6,611 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	6,611	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	6,611	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	6,611	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	95

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.49318 in	S_{POST}=	$\frac{1000}{95} - 10$
Q_{POST}=	0.06131 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.49)]^2}{[(1.00 * 1.17)+(0.8 * 0.49)]} \times \frac{1ft}{12in}$
V_{GOAL}=	405.32 ft^3	V_{GOAL}=	(0.06131)(6,611)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	6,611	ft^2 =	0.15177 Acres
C_{POST} [10] =	0.66		
K [7] =	1.2		

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Solution:

$Q_{TREATMENT}$= 0.02344 cfs

$Q_{TREATMENT}$= (0.2)(0.1518)(0.66)(1.17)

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Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	6,611	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	95

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 59.50 ft^3

V_{PRE}= (0.00900)(6,611)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.49318 in

$$S_{POST} = \frac{1000}{95} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05433 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.49)]^2}{[(0.92*1.17)+(0.8*0.49)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 359.18 ft^3

V_{POST}= (0.05433)(6,611)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (359.18) - (59.50)

V_{DELTA}= 299.68 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 921.18 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 441.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 405 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.1 ft	Below perforated pipe if present
W =	21.0 ft	
L =	21.0 ft	

Solution:

Percent of Goal Achieved = 100.53 % = [(2.1 x 441) / 921] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 299.68 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #60 TYPICAL FOR ALL COTTAGES

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **2,700** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(2,700 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(2,700 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	2,700	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	2,700	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	2,700	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	98

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.20408 in	S_{POST}=	$\frac{1000}{98} - 10$
Q_{POST}=	0.08001 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.20)]^2}{[(1.00 * 1.17)+(0.8 * 0.20)]} \times \frac{1ft}{12in}$
V_{GOAL}=	216.03 ft^3	V_{GOAL}=	(0.08001)(2,700)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	2,700	ft^2 =	0.06198 Acres
C_{POST} [10] =	0.70		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.01015 cfs

$Q_{TREATMENT}$= (0.2)(0.0620)(0.70)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

$$S = \frac{1000}{CN} - 10$$

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	2,700	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	98

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 24.30 ft^3

V_{PRE}= (0.00900)(2,700)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.07240 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.20)]^2}{[(0.92*1.17)+(0.8*0.20)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 195.48 ft^3

V_{POST}= (0.07240)(2,700)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (195.48) - (24.30)

V_{DELTA}= 171.18 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

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LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 490.97 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 100.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 216 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.9 ft	Below perforated pipe if present
W =	5.0 ft	
L =	20.0 ft	

Solution:

Percent of Goal Achieved = 100.62 % = [(4.9 x 100) / 491] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 171.18 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2593.46 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 600.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,141 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.3 ft	Below perforated pipe if present
W =	24.5 ft	
L =	24.5 ft	

Solution:

Percent of Goal Achieved = 100.45 % = [(4.3 x 600) / 2,593] x 100

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 939.50 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

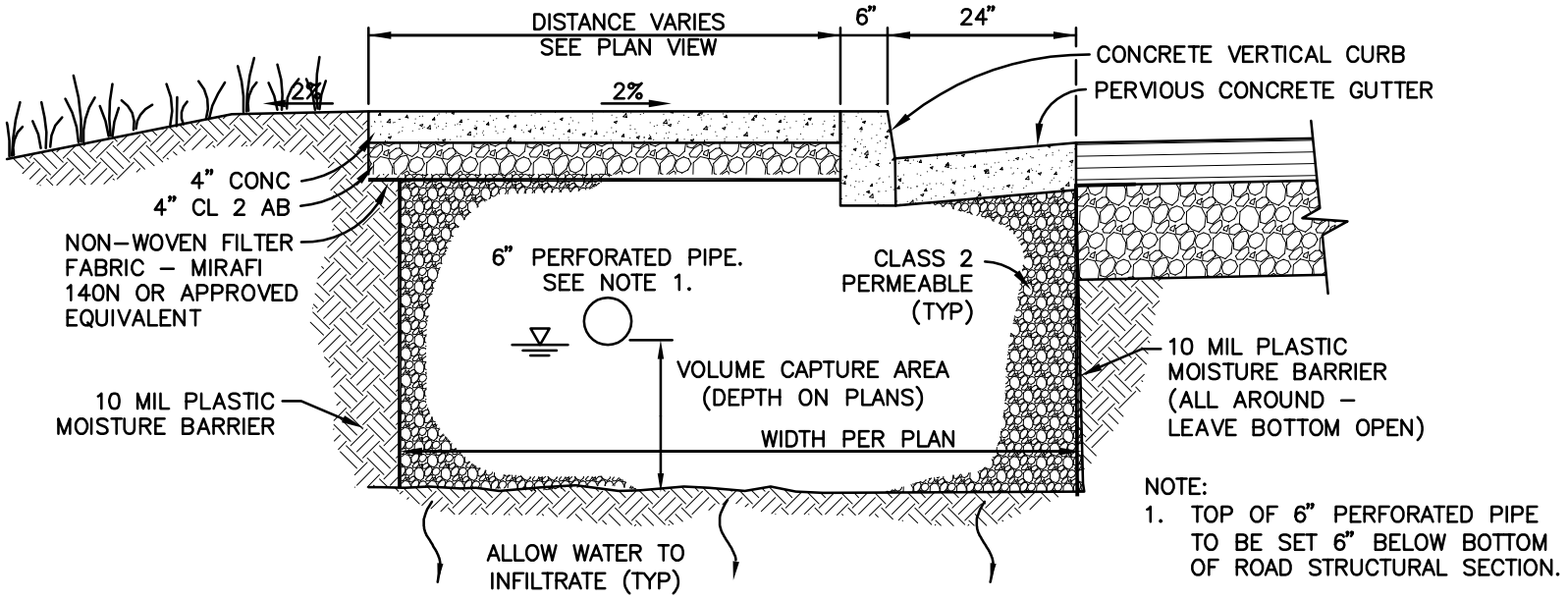
P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

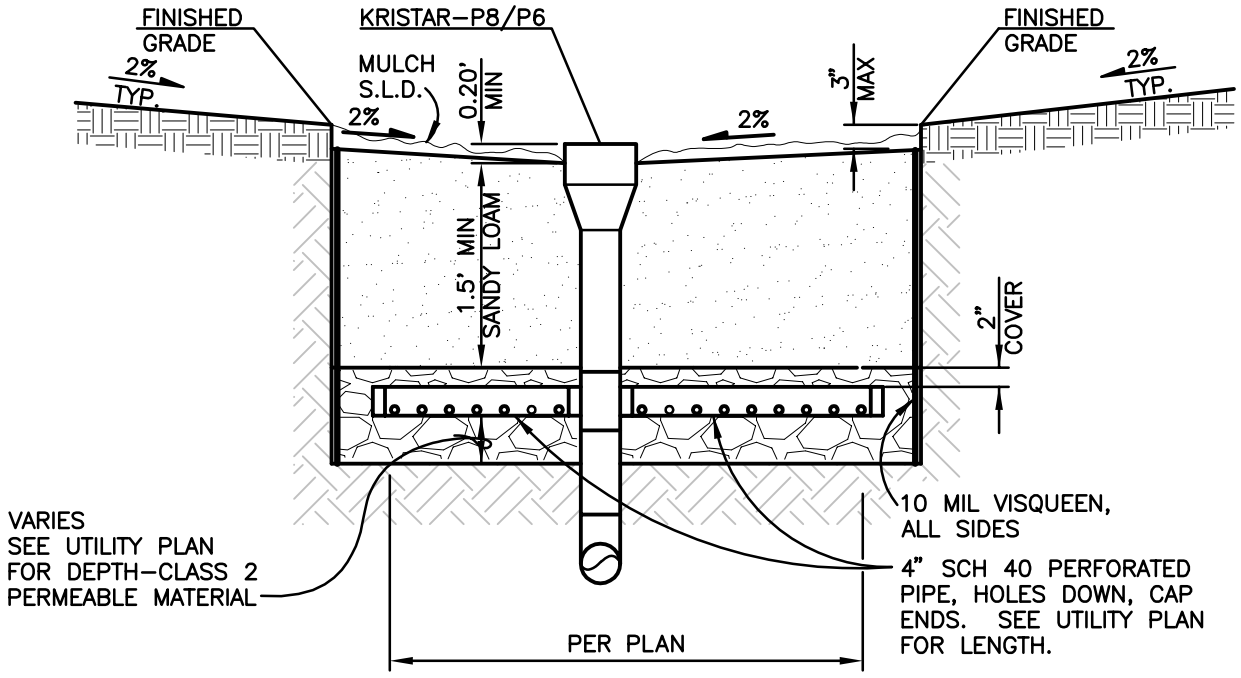
INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

377



PERVIOUS GUTTER WITH BIORETENTION

NOT TO SCALE

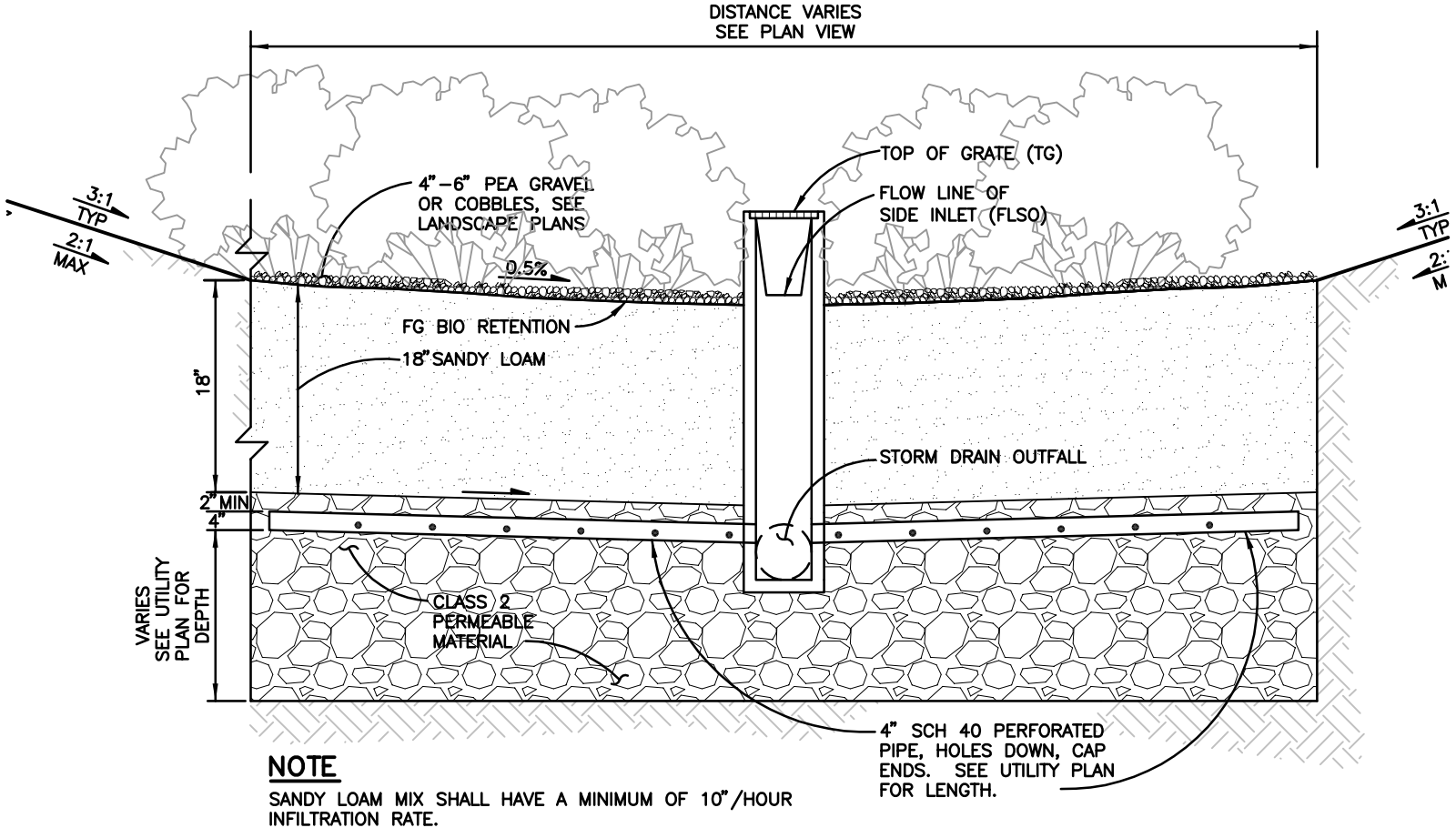


NOTE

SANDY LOAM MIX SHALL HAVE A MINIMUM OF 10"/HOUR INFILTRATION RATE.

BIOINFILTRATION PLANTER TYPE B

NOT TO SCALE

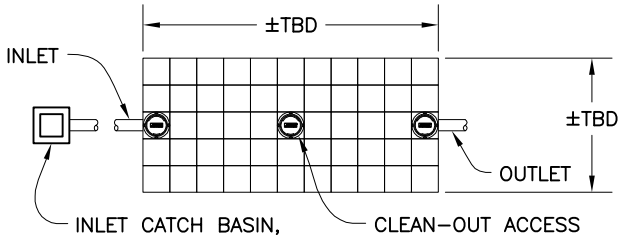


NOTE

SANDY LOAM MIX SHALL HAVE A MINIMUM OF 10"/HOUR INFILTRATION RATE.

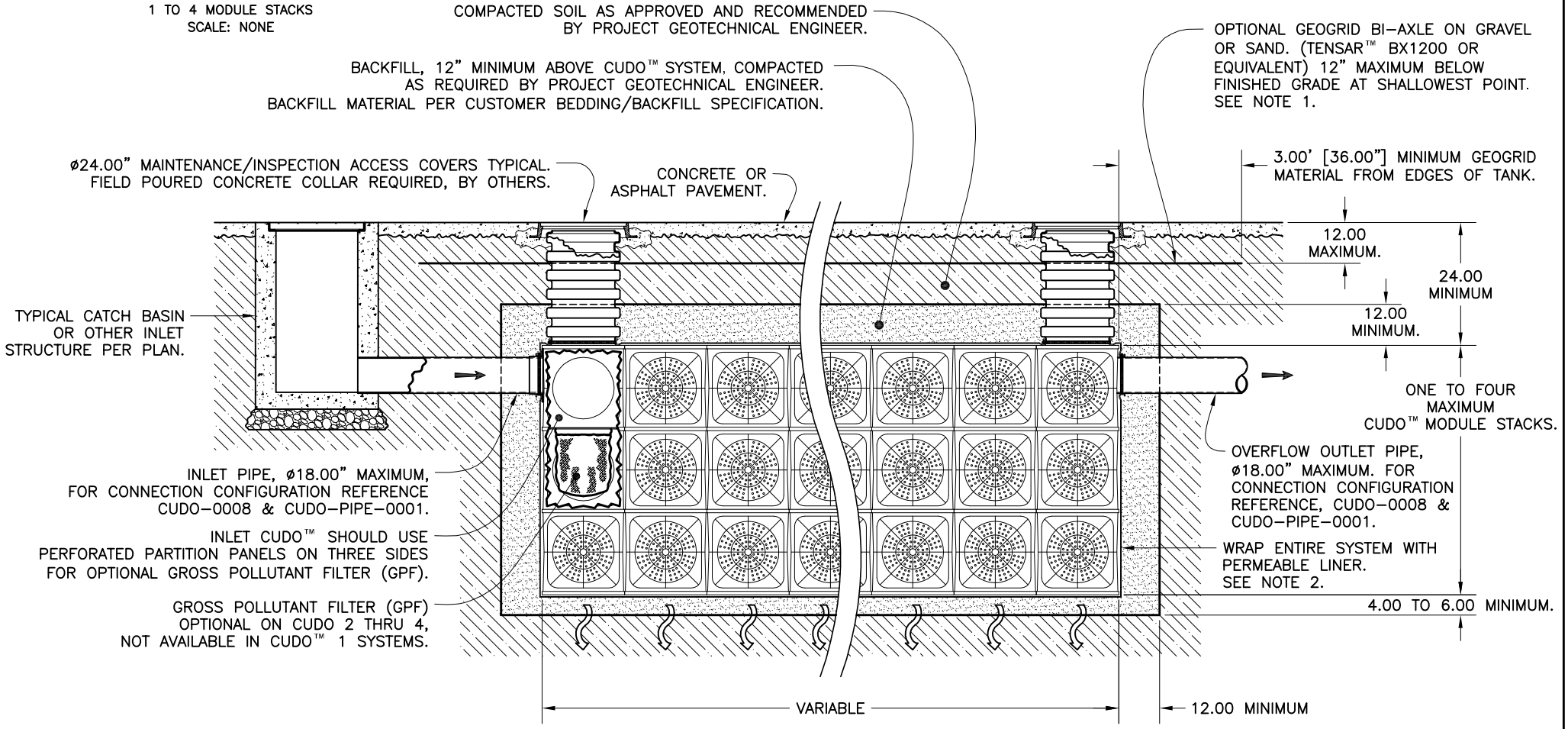
BIORETENTION PLANTER TYPE A

NOT TO SCALE



PLAN VIEW

1 TO 4 MODULE STACKS
SCALE: NONE



SECTION / CUTAWAY VIEW

SCALE: NONE

NOTES:

1. INSTALL GEOGRID LAYER, (TENSAR™ BX1200 OR EQUIVALENT) IN ACCORDANCE WITH MANUFACTURER RECOMMENDATIONS.
2. SYSTEM ENCASED ENTIRELY WITH NONWOVEN POLYPROPYLENE GEOTEXTILE FILTER FABRIC AS REQUIRED.
3. FIELD POURED CONCRETE COLLAR REQUIRED AROUND ALL ACCESS COVERS & HATCHES, BY OTHERS.
4. ALL EXTERNAL PIPING & ANGLES BY OTHERS. REFER TO PLANS.

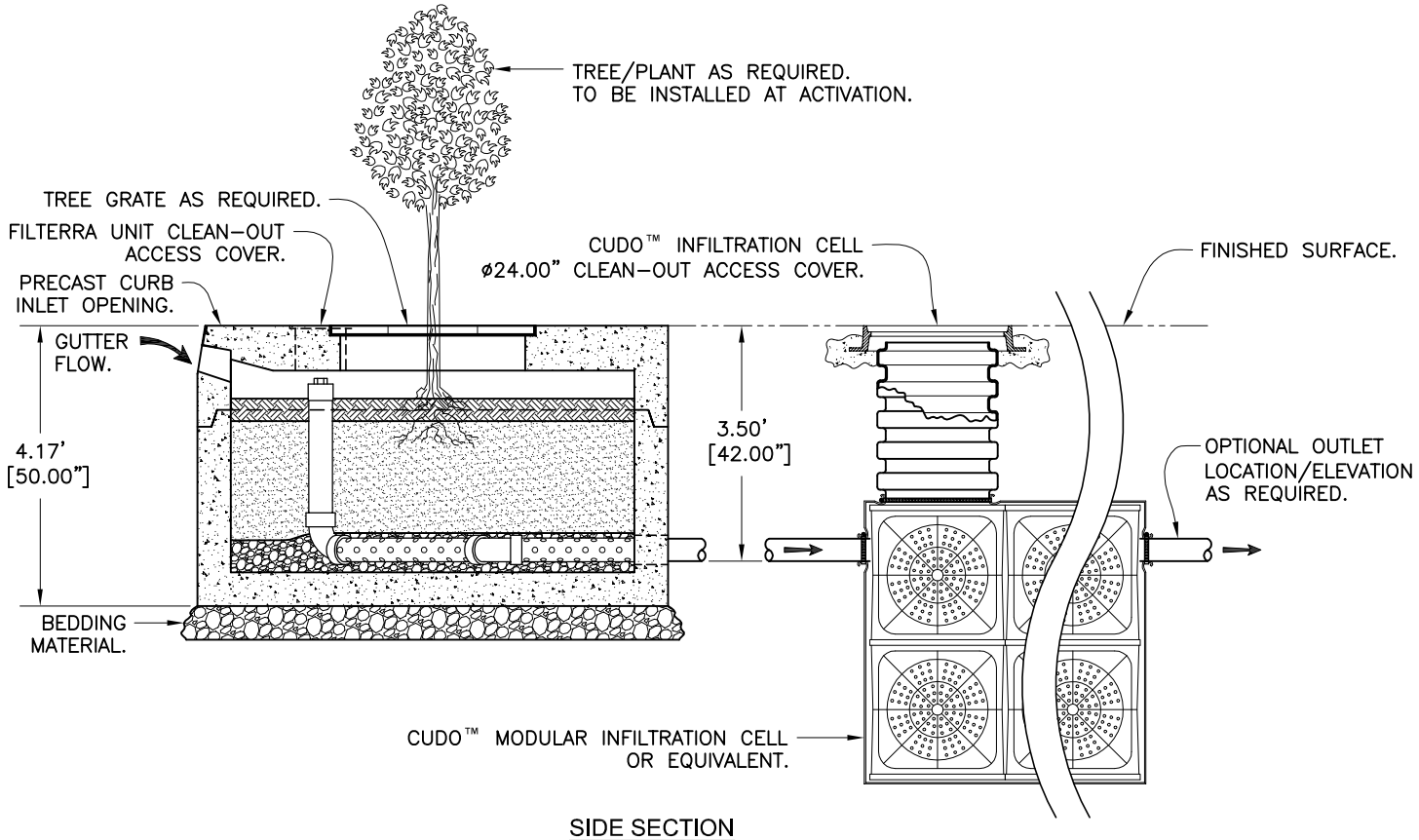
KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

TITLE: CUDO™ Stormwater Infiltration System
Typical Installation Detail
Impermeable Pavement Area

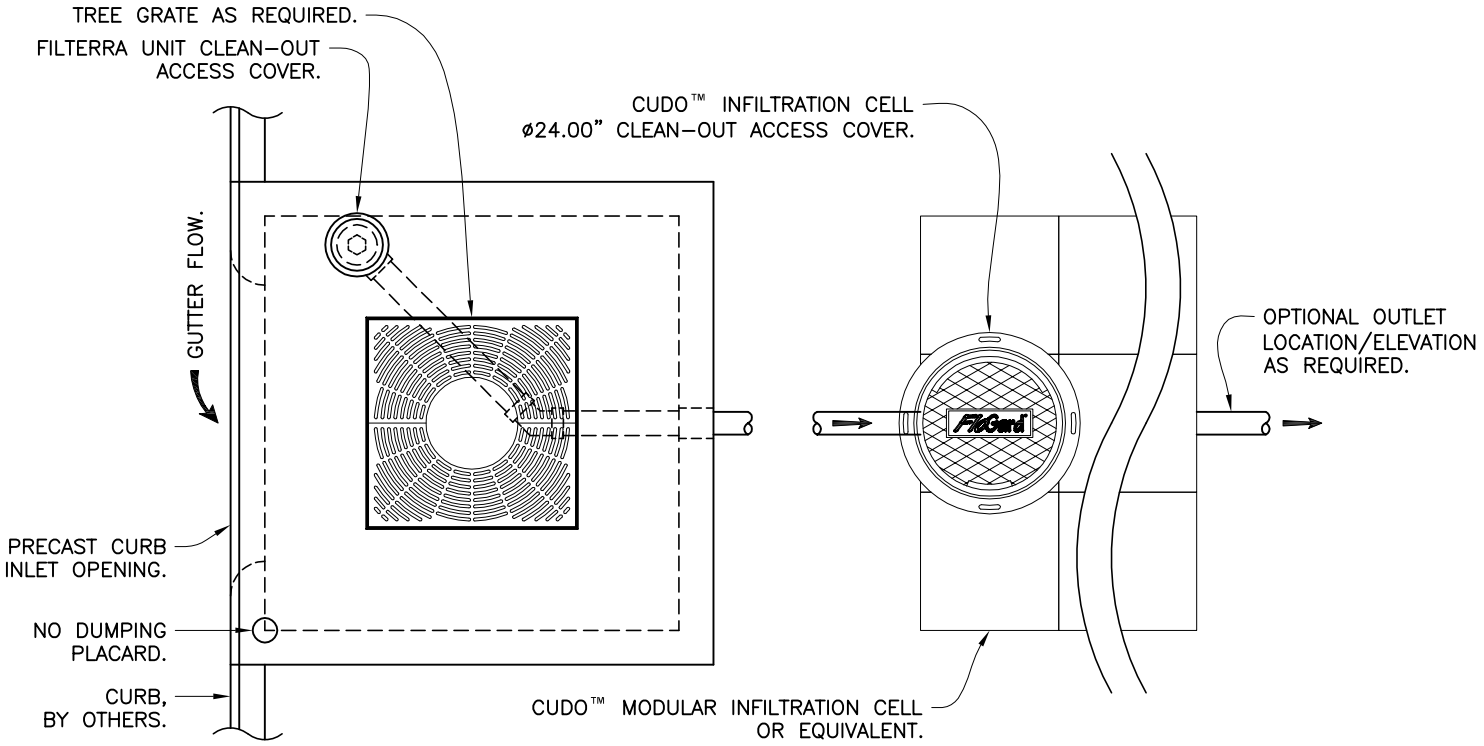
KRISTAR'S STANDARD DETAILS DEMONSTRATE RECOMMENDATIONS FOR INSTALLATION AND/OR STANDARD DIMENSIONS OF KRISTAR PRODUCTS. KRISTAR'S DETAILS DO NOT SUPERSEDE ANY FEDERAL, STATE OR LOCAL AGENCY REGULATIONS. IT IS THE RESPONSIBILITY OF THE CONSULTING ENGINEER TO ENSURE COMPLIANCE WITH ALL REGULATORY AND DESIGN RELATED REQUIREMENTS. KRISTAR HAS NOT AUTHORIZED AND IS NOT RESPONSIBLE FOR ANY ALTERATIONS BY OTHERS TO THE KRISTAR STANDARD DETAILS.

DO NOT SCALE DRAWING	SCALE: NONE	DRAWN / DATE: JPR 7/21/08	CUDO ECO: 0005 JPR 3/20/12	DRAWING NO.: CUDO-IN-0001	REV: B	SHEET 1 OF 1

K-FTHYD



SIDE SECTION



PLAN VIEW

MODIFICATION OF DRAWINGS IS PERMITTED ONLY BY WRITTEN AUTHORIZATION FROM KRISTAR ENTERPRISES, INC.

TITLE

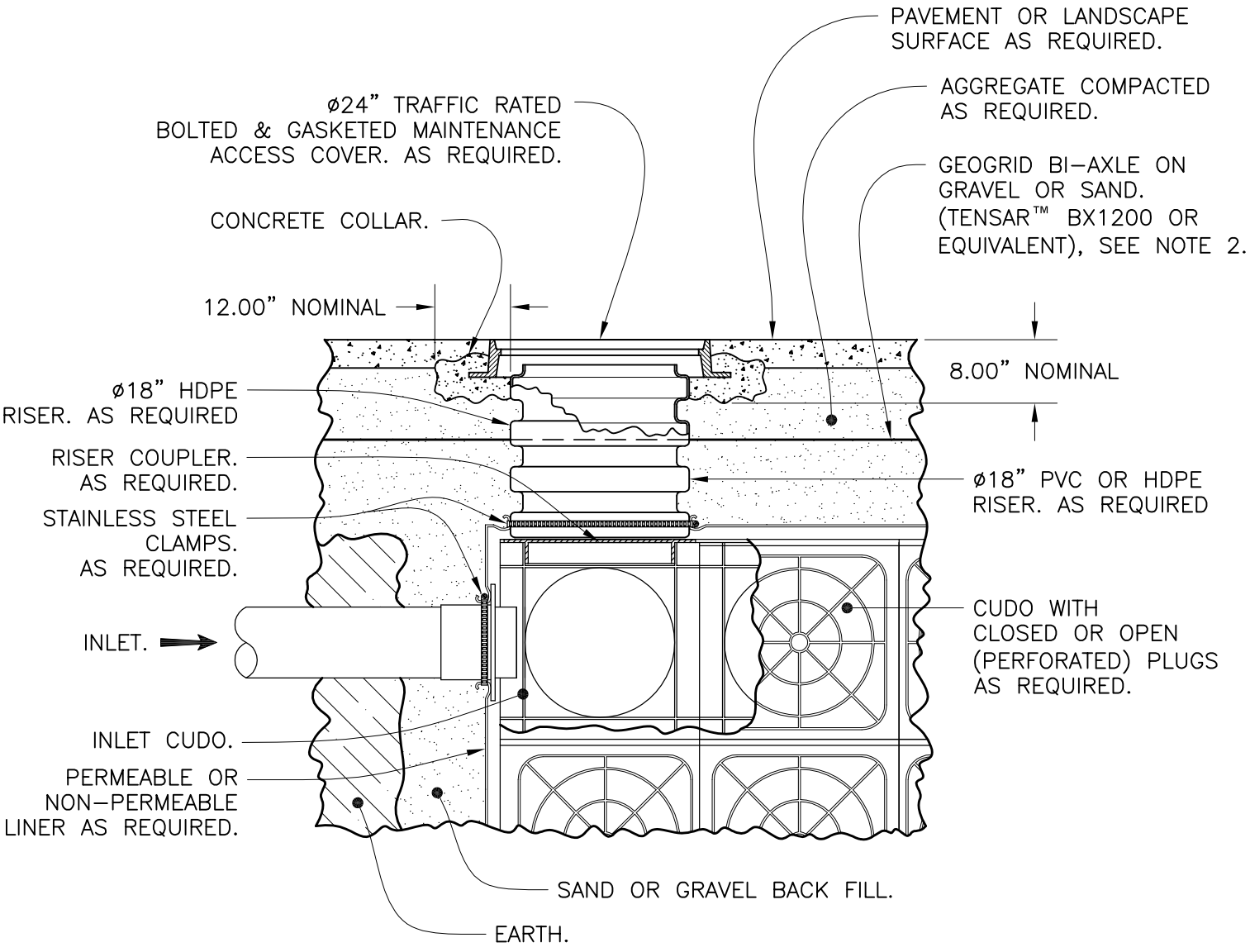
Typical Filterra®
Hydromodification Configuration

KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

filterra®
US PAT 6,277,274
AND 6,569,321

DRAWING NO.	REV	F-ECO	DATE
K-FTHYD	01	0006 JPR 6/17/11	JPR 6/17/11

CUDO-0008



NOTES:

1. REFER TO CUDO INSTALLATION DETAILS.
2. INSTALL GEOGRID LAYER, (TENSAR™ BX1200 OR EQUIVALENT) IN ACCORDANCE WITH MANUFACTURER RECOMMENDATIONS IN AREAS SUBJECT TO VEHICLE TRAFFIC,

CUDO™ Water Storage System
TYPICAL MAINTENANCE ACCESS

KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

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DO NOT SCALE DRAWING	SCALE: NONE	DRAWN / DATE JPR 5/2/08	CUDO ECO 0006 JPR 3/26/12	DRAWING NO. CUDO-0008	REV B	SHEET 1 OF 1

CUDO-PIPE-0001

ø24" CAST IRON OR OPTIONAL FIBERGLASS ACCESS COVER.

ø18" CORRUGATED PVC OR HDPE ACCESS RISER..

PLASTIC OR GEOTEXTILE FABRIC BOOT. ATTACHED TO LINER PER MANUFACTURERS SPECIFICATION.

STAINLESS STEEL CLAMP.

MAINTENANCE ACCESS ASSEMBLY. FIELD POURED CONCRETE COLLAR REQUIRED AROUND ALL ACCESS COVERS, (NOT SHOWN), BY OTHERS.

LATERAL CUDO™ COUPLER.

INLET/OUTLET ASSEMBLY.

ø18" PLASTIC OR GEOTEXTILE FABRIC BOOT. ATTACHED TO LINER PER MANUFACTURERS SPECIFICATION.

PLASTIC OR GEOTEXTILE FABRIC LINER.

ø18" LATERAL CUDO™ COUPLER.

CUDO™ WATER STORAGE SYSTEM.

STAINLESS STEEL CLAMP.

REDUCER/PIPE (ø18 MAXIMUM) BY OTHERS.

INLET / OUTLET CONNECTION WITH REDUCER

CUDO™ Water Storage System

Pipe Connection & Maintenance Access Installation Diagram

KriStar Enterprises, Inc.

360 Sutton Place, Santa Rosa, CA 95407

Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

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DO NOT SCALE DRAWING	SCALE: NONE	DRAWN / DATE JPR 7/22/09	CUDO ECO 0005 JPR 3/20/12	DRAWING NO. CUDO-PIPE-0001	REV A	SHEET 2 OF 2

PLANTER STRIP BIORETENTION- CHECKLIST

Planter Strip Bioretention
Inspection and Maintenance Checklist
(aka: Street Rain Garden, Roadside Bioretention, Bioretention Cell)

Date of Inspection: _____
Inspector(s): _____
BMP ID #: _____
Property Owner: _____

Location Description: _____

Type of Inspection: ☐ Pre-rainy Season (PRS) ☐ Rainy Season (RS) ☐ After-rainy Season (ARS)

This Inspection and Maintenance Checklist is to be used in conjunction with its corresponding LID Factsheet and Maintenance Plan. Please review these documents before performing the field inspection.

Inspection Category	When to Inspect	Maintenance Issue	Is the Issue Present?	Require Maintenance	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)
Drainage	RS	Is there standing or pooling of water in the Bioretention area after 3 days of dry weather?		• Check perforated pipe outlet for obstruction or damage. * • Flush perforated pipe to remove obstructions/sediment. * • Remove and replace the first few inches of topsoil. • Remove soil and inspect perforated pipe. Repair or replace perforated pipe, replace with new soil and regrade.	
		Is water not draining into catch basin from the overflow pipe during a high intensity storm? *			
	PRS RS ARS	Is there sediment visible in the gutter?		• In dry weather, use a mechanical sweeper or a Vactor truck to clean gutter pan.	
	RS	Is there water flowing in the pervious concrete gutter section during a low intensity storm? *		• In wet weather, use a Vactor truck to clean gutter pan.	

* If perforated pipe is present.

PLANTER STRIP BIORETENTION- CHECKLIST

Inspection Category	When to Inspect	Maintenance Issue	Is the Issue Present?	Require Maintenance	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)
Erosion	RS ARS	Is there under cutting or washouts along the sidewalks and/or curbs abutting the planter strip?		• Fill in eroded areas and regrade.	
	RS ARS	Is there channelization (gully) forming along the length of the planter area?		• Fill in eroded areas and regrade.	
	RS ARS	Is there accumulation of sediment (sand, dirt, mud) in the planter?		• Remove sediment and check the grading. Add replacement soil and/or mulch.	
	PRS RS ARS	Is the mulch unevenly distributed in the planter area?		• Redistribute and add additional mulch if needed. • Regrade planter area.	
	PRS RS ARS	Are there voids or deep holes present? Is there sediment present in the catch basin and in the overflow pipe?		• Check the perforated pipe for damage.*	
	PRS RS ARS	Is there evidence of animal activity such as holes or dirt mounds from digging or borrowing?		• Repair and fill in damage areas. • Rodent control activities must be in accordance with applicable laws and do not affect any protected species.	

* If perforated pipe is present.

PLANTER STRIP BIORETENTION- CHECKLIST

Inspection Category	When to Inspect	Maintenance Issue	Is the Issue Present?	Require Maintenance	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)
Vegetation	PRS RS ARS	Is the vegetation clogging the inlet flow areas?		• Trim and/or remove the excess vegetation.	
	PRS RS ARS	Is the mulch distributed evenly throughout the planter area?		• Redistribute and add additional mulch if needed. • Regrade planter area.	
	PRS RS ARS	Are there dead or dry plants/weeds? Is the vegetation over grown?		• Remove dead and/or dry vegetation. Replace as needed. • Remove or trim any vegetation that is causing a visual barrier, trip, and or obstruction hazard.	

PLANTER STRIP BIORETENTION- CHECKLIST

Inspection Category	When to Inspect	Maintenance Issue	Is the Issue Present?	Require Maintenance	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)
BMP General	PRS RS ARS	Is there debris/trash in the planter area?		• Remove all trash and debris.	
	PRS RS ARS	Is graffiti present?		• Remove all graffiti from the area.	
	PRS RS ARS	Are there missing or disturbed aesthetics features?		• Replace and/or reposition aesthetics features to original placement. • Placement should not disrupt flow characteristics/design.	
	PRS RS ARS	Is the vegetation irrigation functional?		• Repaired broken missing spray/drip emitters. • Reposition and/or adjust to eliminate over spray and/or over watering.	
	PRS RS ARS	Are the aesthetic features firmly secured in placed?		• Repair and/or replace loose or damage features.	
	PRS RS ARS	Check for damage sidewalk, curb, gutter, and catch basin including uplift and settling.		• Remove and replace damaged areas.	

CUDO™ Stormwater Cube

(Underground Retention / Detention / Infiltration / Water Reuse Systems)

Operations and Maintenance Manual

Version 1.01 – July 08, 2009

CUDO™ Stormwater Cube – Modular Stormwater Systems

Description / Basic Function
CUDO™ is a modular stormwater system comprised of a grouping of modular polypropylene or concrete cubes that when constructed form an underground storage area for stormwater. This system can be used for infiltration, retention, detention or water reuse. CUDO™ can help achieve runoff detainment and storage to help attenuate the peak flow to pre-construction levels and can help conform to current Low Impact Development requirements.

Infiltration
The purpose of a CUDO™ infiltration system is to capture stormwater runoff, store the runoff, and then allow it to percolate into the ground via the open space area of the cubes and perforations in the side wall. The system is backfilled with a Class I material defined by ASTM D2321 as a cleaned open graded rock or a Class II permeable sand. The rock or sand provide additional storage capacity but also allow for a percolation interface with the native material. The ground water is "recharged" with this type of system.

Detention
The purpose of a CUDO™ detention system is to capture stormwater runoff, store the runoff, and then allow it to be released at a controlled rate through an appropriately sized orifice control. A detention system helps attenuate the peak flow from the site assuring that pre-development runoff flows are not exceeded as a result of the development. A CUDO™ detention requires the cubes to be encapsulated with an impermeable liner for the polypropylene system or the seams of the concrete system to be sealed with a water proof mastic.

Retention
A CUDO™ retention system is a hybrid system. It is a combination of a detention system and an infiltration system. A retention system is utilized to attenuate peak flow as well as promote groundwater re-charge. A retention system is outfitted with an overflow pipe at the top of the system which allows the system to fill for infiltration but also outlet if the ground is saturated.

Water Reuse
The purpose of a water-reuse CUDO™ system is to capture and store water for future use. The system is constructed in a similar fashion to a detention system but instead of a controlled outlet the system is constructed with an emergency overflow. A water reuse system is a LID device that helps attenuate peak flows as well as conserve water. Water may be reused through an active pump system or passive irrigation.

Inspection/Cleanout Ports
Inspection and cleanout ports are 18-inch diameter vertical risers connected to the uppermost polypropylene CUDO™ cubes or up to 30-inch manhole access connected to the concrete CUDO™. They are used for entrance into the system, or for access to place vacuum truck hoses or water-jetting devices or CCTV equipment. Ports are strategically located near inlet and outlet pipes and in other areas or probable deposition in the system. It is recommended to keep surface level access lids sealed and bolted at all times when the system is in service.

Inlet Bay
Some systems are configured so that pretreatment of the stormwater occurs within the CUDO™ system. In this case the CUDO™ system will house an inlet bay. The inlet bay is separated from the rest of the CUDO™ system by sidewall plugs and is intended to separate gross pollutants, trash and debris and floatables from the CUDO™ system and pre-treatment device. The bay contains its own sump area and unique access ports.

Maintenance Overview for CUDO

State and Local regulations require that stormwater storage systems be maintained and serviced on a recurring basis. The purpose of maintaining a clean and obstruction free CUDO™ system is to ensure the system performs the intended function of the primary design. Trash and debris, floatables, gross pollutants and sediment can build up in the CUDO™ leading to clogging of the native soil interface or blockage of the inlet or outlet pipes. This can cause the system to function improperly by limiting storage volume, limiting the design percolation rates or impeding flow in and out of the system. Downstream and upstream, areas could run the risk of flooding and deleterious environmental impact.

Recommended Frequency of Service

It is recommended that the CUDO™ stormwater systems be serviced on a regularly occurring basis. Ultimately the frequency depends on the amount of runoff, pollutant loading, and interference from trash, debris and gross pollutants as well as proper maintenance of upstream pretreatment devices. However, it is recommended that each installation be inspected at least two times per year to assess service needs.

Recommended Timing of Service

Guidelines for the timing of service are as follows:

1. For areas with a definite rainy season the system should be serviced prior to and following the rainy season.
2. For areas subject to year-round rainfall service should occur on a regularly occurring basis. (A minimum of two times per year.)
3. For areas with winter snow and summer rain the system should be serviced prior to and after the snow season.
4. For installed devices that are subject to dry weather flows only (i.e. wash racks, parking garages, etc…) the unit should be serviced on a regularly occurring basis. (A minimum of two times per year.)

Inspection

An inspection should be performed when the system is new. This allows the owner to establish a baseline condition for comparison to future inspections. Sediment build up can typically be monitored without entering the system. (No confined space entry.) Initial and subsequent inspection data should be recorded and filed for reference. Some regulatory agencies require that the results of the inspections be documented and reported. Inspection reports should comply with regulatory requirements and be submitted as required.

Inspection Procedures

1. Locate the inspection, cleanout and access ports. Inspection and cleanout ports are typically 18-inch diameter. Access ports are typically 24-inch or 30-inch diameter. Pictures should be taken to document the location or a site map should be generated to detail the as-built locations of the ports.
2. Unbolt and remove the access port lids.
3. Insert a measuring device into the opening making note of a point of reference to determine the quantity of sediment and other accumulated material. If access is required to measure, ensure only certified confined space entry personnel having appropriate equipment are allowed to enter the system.
4. In addition, for accessible concrete CUDO™ systems personnel should utilize appropriate confined space entry procedures to enter the system and photograph its condition.
5. Inspect inlet and outlet locations for obstructions. Obstructions should be removed at this time.
6. Inspect the structural components of the system.
7. Fill in the CUDO™ Inspection/Maintenance Data Sheet and send a copy to the regulatory agency if necessary.

Disinfection of Water Reuse System

Periodic disinfection of water held for reuse may be required to abate bacteria and algae growth. This may be done using calcium hypochlorite tablets or by the addition of an ozone generator in a small recirculation system.

Maintenance
Cleanout of the CUDO™ system should be considered if there is sediment buildup of two or more inches at over 50% of the inspection ports. Cleaning shall be performed if sediment buildup is two inches or more over 75% of the system floor. In the event of a spill of a foreign substance, cleanout of the system should be considered.

Maintenance Procedures

1. Locate the inspection, cleanout and access ports. Inspection and cleanout ports are typically 18-inch diameter. Access ports are typically 24-inch or 30-inch diameter. Pictures should be taken to document the location or a site map should be generated to detail the as-built locations of the ports.
2. Unbolt and remove the access port lids.
3. Measure the sediment buildup at each port. If access is required to measure ensure only certified confined space entry personnel having appropriate equipment are allowed to enter the system.
4. A thorough cleaning of the system (inlets, outlets, ports, and inlet bays) shall be performed by either a vacuum truck or by manual methods.
5. Inspect inlet and outlet locations for obstructions. Obstructions should be removed at this time.
6. Inspect the structural components of the system.
7. Fill in the CUDO™ Inspection/Maintenance Data Sheet and send a copy to the regulatory agency if necessary.

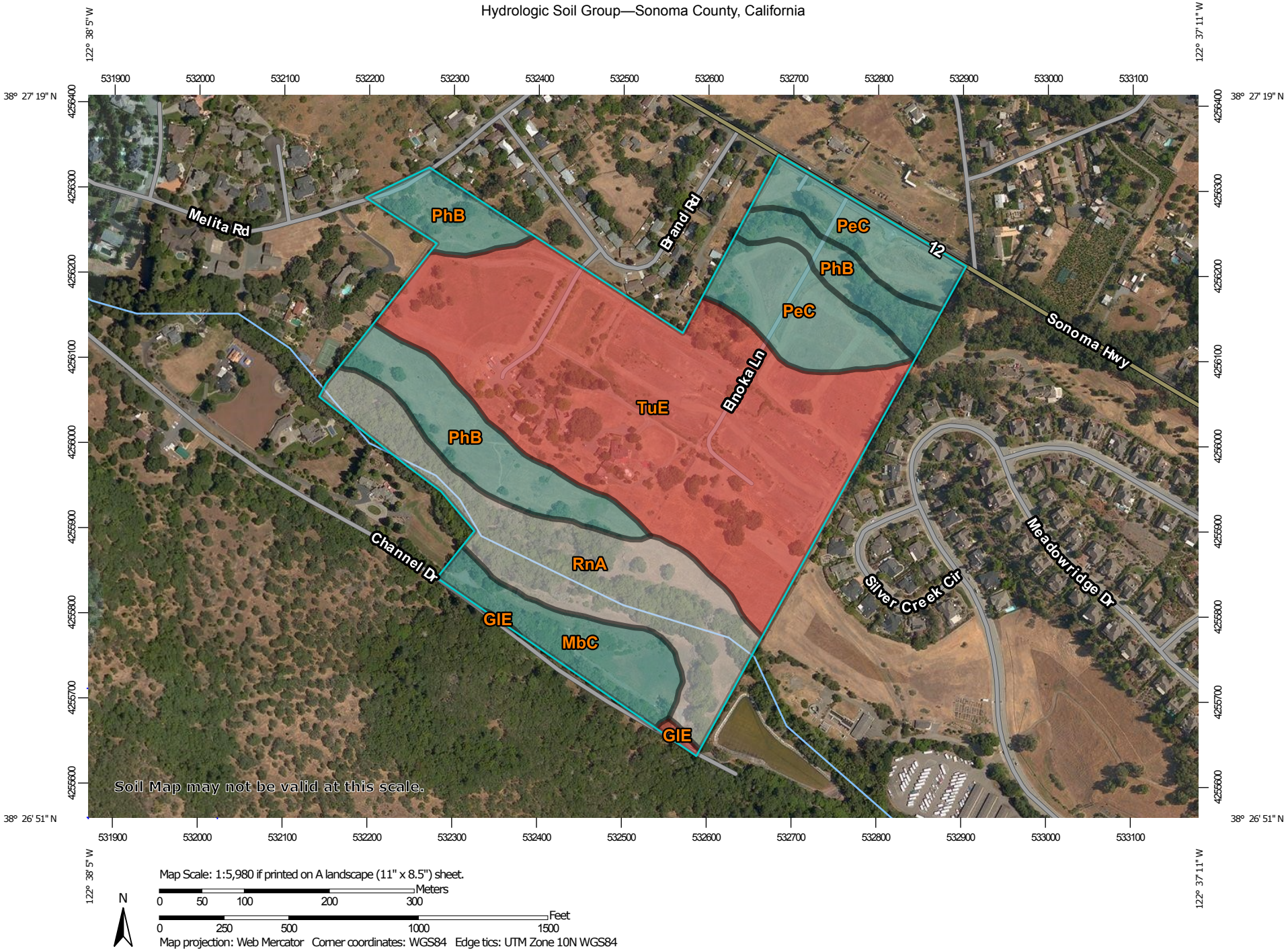
Inspection / Maintenance Requirements
Listed below are some recommendations for equipment and training for personnel to inspect and maintain a CUDO™ system.

Personnel – OSHA Confined Space Entry Training is a prerequisite for entrance into a system. In the state of California personnel should be CalOSHA certified.

Equipment – Record Taking (pen, paper, voice recorder)
Proper Clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
Flashlight
Tape Measure
Measuring Stick
Pry Bar
Traffic Control (Flagging, barricades, signage, cones, etc.)
First aid materials
Debris and Contaminant collectors
Debris and Contaminant containers
Vacuum Truck

Disposal of Gross Pollutants, Hydrocarbons, and Sediment
The collected gross pollutants, hydrocarbons, and sediment shall be offloaded from the vacuum truck into DOT approved containers for disposal. Once in the container the maintenance contractor has possession and is responsible for disposal in accordance with local, state and federal agency requirements.

Note: As the generator, the landowner is ultimately responsible for the proper disposal of the collected materials. Because the material likely contains petroleum hydrocarbons, heavy metals, and other harmful pollutants, the materials must be treated as EPA class 2 Hazardous Waste. Proper disposal is required.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Sonoma Hwy
Enoka Ln
Channel Dr
Silver Creek Cir
Meadowridge Dr
PhB
PeC
TuE
RnA
GIE
MbC
Soil Map may not be valid at this scale.
Map Scale: 1:5,980 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 50 100 200 300
Feet
0 250 500 1000 1500
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Sonoma County, California
Survey Area Data: Version 10, Sep 27, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 29, 2015—Jun 3, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Sonoma County, California (CA097)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
GlE	Goulding cobbly clay loam, 15 to 30 percent slopes	D	0.2	0.3%
MbC	Manzanita gravelly silt loam, 0 to 9 percent slopes	C	4.7	6.7%
PeC	Pleasanton loam, 2 to 9 percent slopes, MLRA 14	C	8.9	12.9%
PhB	Pleasanton clay loam, 2 to 5 percent slopes	C	11.0	15.8%
RnA	Riverwash		12.1	17.5%
TuE	Tuscan cobbly clay loam, 9 to 30 percent slopes	D	32.4	46.8%
Totals for Area of Interest			**69.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

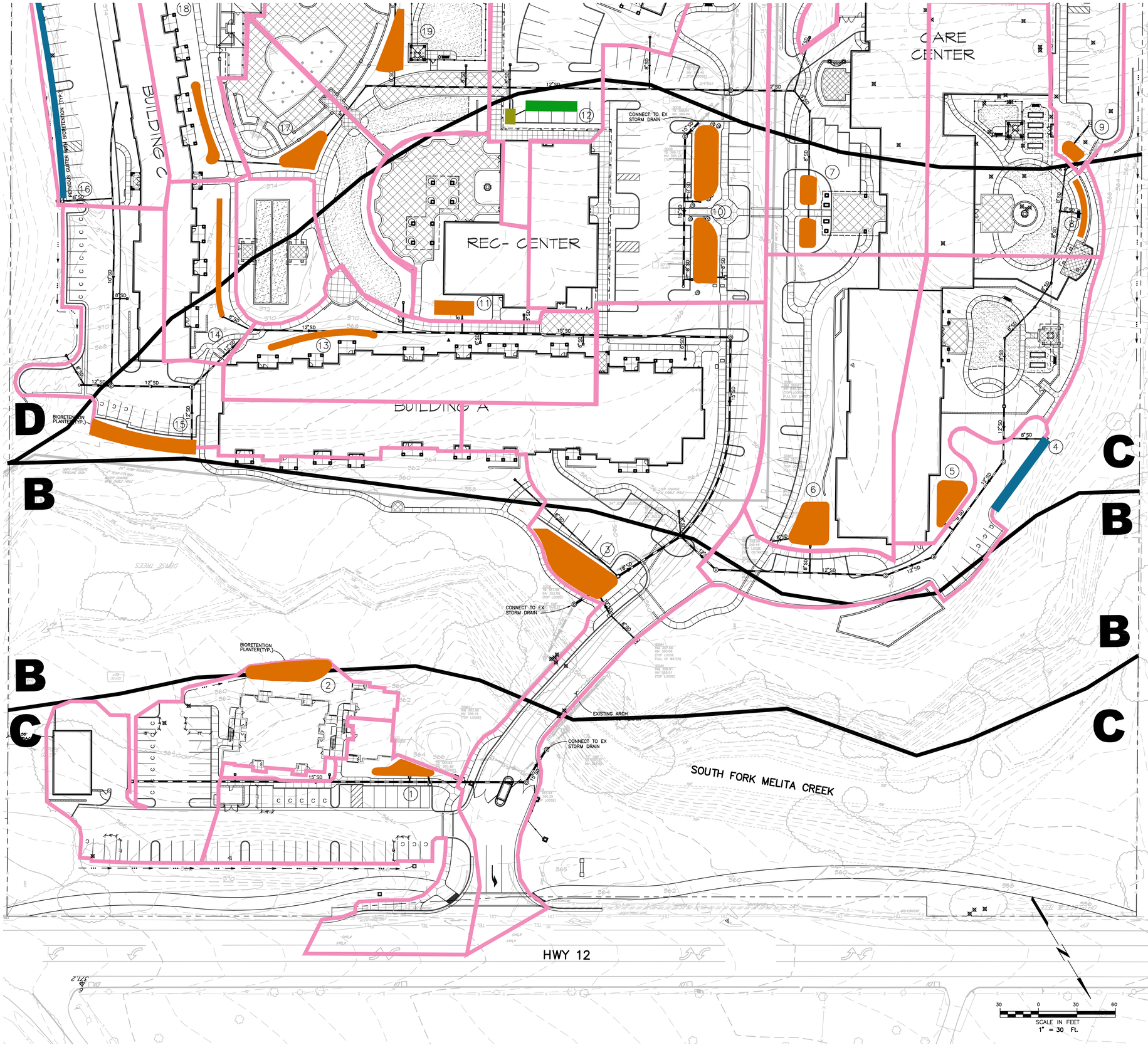
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



DMA AREA #	TOTAL AREA (sf)	CN POST	C POST	PROPOSED BMP TYPE	PROPOSED BMP SIZE
1	20,850	94.2	0.60	BIORETENTION TYPE A	600 SF OF SURFACE AREA, 4.3' BELOW SUBDRAIN
2	24,049	93.7	0.59	BIORETENTION TYPE A	900 SF OF SURFACE AREA, 3.2' BELOW SUBDRAIN
3	48,548	93.6	0.59	BIORETENTION TYPE A	1,555 SF OF SURFACE AREA, 3.7' BELOW SUBDRAIN
4	12,728	96.3	0.66	PERVIOUS GUTTER WITH BIORETENTION	485 SF OF SURFACE AREA, 4.0' BELOW SUBDRAIN
5	22,393	85.1	0.38	BIORETENTION TYPE A	595 SF OF SURFACE AREA, 1.9' BELOW SUBDRAIN
6	25,625	90.4	0.51	BIORETENTION TYPE A	880 SF OF SURFACE AREA, 2.5' BELOW SUBDRAIN
7	25,490	93.1	0.58	BIORETENTION TYPE A	625 SF OF SURFACE AREA, 4.4' BELOW SUBDRAIN
8	21,834	88.7	0.47	BIORETENTION TYPE A	324 SF OF SURFACE AREA, 5.0' BELOW SUBDRAIN
9	8,414	92.1	0.50	BIORETENTION TYPE A	205 SF OF SURFACE AREA, 4.2' BELOW SUBDRAIN
10	39,220	91.5	0.54	BIORETENTION TYPE A	1,913 SF OF SURFACE AREA, 2.0' BELOW SUBDRAIN
11	14,350	90.8	0.52	BIORETENTION TYPE A	340 SF OF SURFACE AREA, 3.8' BELOW SUBDRAIN
12	26,208	91.9	0.55	TREEPOD WITH UNDERGROUND RETENTION	8'X40'X5.5' DEEP UNDERGROUND RETENTION
13	19,862	91.5	0.54	BIORETENTION TYPE A	451 SF OF SURFACE AREA, 4.2' BELOW SUBDRAIN
14	8,121	87.4	0.43	BIORETENTION TYPE A	370 SF OF SURFACE AREA, 1.4' BELOW SUBDRAIN
15	24,620	93.6	0.59	BIORETENTION TYPE A	950 SF OF SURFACE AREA, 3.1' BELOW SUBDRAIN
16	24,684	92.8	0.53	PERVIOUS GUTTER WITH BIORETENTION	745 SF OF SURFACE AREA, 3.6' BELOW SUBDRAIN
17	13,521	88.4	0.38	BIORETENTION TYPE A	620 SF OF SURFACE AREA, 1.5' BELOW SUBDRAIN
18	12,302	90.8	0.46	BIORETENTION TYPE A	420 SF OF SURFACE AREA, 2.6' BELOW SUBDRAIN
19	20,821	87.8	0.36	BIORETENTION TYPE A	650 SF OF SURFACE AREA, 2.1' BELOW SUBDRAIN
20	15,006	90.8	0.46	BIORETENTION TYPE A	27.4 SF OF SURFACE AREA, 1.8' BELOW SUBDRAIN
21	7,804	98	0.70	PERVIOUS GUTTER WITH BIORETENTION	590 SF OF SURFACE AREA, 2.4' BELOW SUBDRAIN
22	43,427	87.3	0.34	BIORETENTION TYPE A	1,273 SF OF SURFACE AREA, 2.2' BELOW SUBDRAIN
23	23,920	95.6	0.62	PERVIOUS GUTTER WITH BIORETENTION	1,128 SF OF SURFACE AREA, 3.1 BELOW SUBDRAIN
24	34,991	92.9	0.53	PERVIOUS GUTTER WITH BIORETENTION	1,370 SF OF SURFACE AREA, 2.8 BELOW SUBDRAIN
25	33,215	90.6	0.45	BIORETENTION TYPE A	700 SF OF SURFACE AREA, 4.1 BELOW SUBDRAIN
26	51,446	92.0	0.50	BIORETENTION TYPE A	1,035 SF OF SURFACE AREA, 5.0 BELOW SUBDRAIN
27	39,558	90.5	0.45	BIORETENTION TYPE A	970 SF OF SURFACE AREA, 3.5 BELOW SUBDRAIN
28	33,681	89.3	0.41	BIORETENTION TYPE A	650 SF OF SURFACE AREA, 4.0 BELOW SUBDRAIN
29	22,085	96.0	0.63	BIORETENTION TYPE A	750 SF OF SURFACE AREA, 4.4 BELOW SUBDRAIN
30	25,456	93.6	0.55	BIORETENTION TYPE A	761 SF OF SURFACE AREA, 4.0 BELOW SUBDRAIN
31	14,563	93.2	0.54	PERVIOUS GUTTER WITH BIORETENTION	440 SF OF SURFACE AREA, 3.8 BELOW SUBDRAIN
32	7,361	94.6	0.59	BIORETENTION TYPE A	550 SF OF SURFACE AREA, 1.7 BELOW SUBDRAIN
33	7,412	93.8	0.63	PERVIOUS GUTTER WITH BIORETENTION	488 SF OF SURFACE AREA, 1.9 BELOW SUBDRAIN
34	30,425	95.4	0.61	PERVIOUS GUTTER WITH BIORETENTION	1,540 SF OF SURFACE AREA, 2.8 BELOW SUBDRAIN
35	44,444	94.8	0.60	PERVIOUS GUTTER WITH BIORETENTION	2,786 SF OF SURFACE AREA, 2.1 BELOW SUBDRAIN
36	45,025	92.8	0.53	PERVIOUS GUTTER WITH BIORETENTION	2,117 SF OF SURFACE AREA, 2.1 BELOW SUBDRAIN
37	24,028	93.8	0.56	PERVIOUS GUTTER WITH BIORETENTION	1,105 SF OF SURFACE AREA, 2.6 BELOW SUBDRAIN
38	22,242	98	0.70	PERVIOUS GUTTER WITH BIORETENTION	1,450 SF OF SURFACE AREA, 2.8 BELOW SUBDRAIN
39	6,898	98	0.70	PERVIOUS GUTTER WITH BIORETENTION	540 SF OF SURFACE AREA, 2.3 BELOW SUBDRAIN
40	35,086	94.6	0.59	TREEPOD WITH UNDERGROUND RETENTION	8'X66'X5.5' DEEP UNDERGROUND RETENTION
41	43,274	91.5	0.60	PERVIOUS GUTTER WITH BIORETENTION	1,670 SF OF SURFACE AREA, 2.5 BELOW SUBDRAIN
42	19,141	77.70	0.37	BIORETENTION TYPE A	670 SF OF SURFACE AREA, 1.0 BELOW SUBDRAIN
43	12,492	91.0	0.59	BIORETENTION TYPE A	340 SF OF SURFACE AREA, 3.4' BELOW SUBDRAIN
44	27,597	93.5	0.59	TREEPOD WITH UNDERGROUND RETENTION	8'X46'X5.5' DEEP UNDERGROUND RETENTION
45	18,988	92.2	0.56	PERVIOUS GUTTER WITH BIORETENTION	550 SF OF SURFACE AREA, 3.6' BELOW SUBDRAIN
46	24,447	92.3	0.61	BIORETENTION TYPE A	695 SF OF SURFACE AREA, 3.7' BELOW SUBDRAIN
47	14,334	85.6	0.50	BIORETENTION TYPE A	250 SF OF SURFACE AREA, 3.0' BELOW SUBDRAIN
48	19,963	92.2	0.56	PERVIOUS GUTTER WITH BIORETENTION	720 SF OF SURFACE AREA, 2.9' BELOW SUBDRAIN
49	4,087	92.2	0.56	TREEPOD WITH UNDERGROUND RETENTION	4'X12'X5.5' DEEP UNDERGROUND RETENTION
50	46,173	94.5	0.61	TREEPOD WITH UNDERGROUND RETENTION	10'X68'X5.5' DEEP UNDERGROUND RETENTION
51	11,547	92.1	0.50	PERVIOUS GUTTER WITH BIORETENTION	600 SF OF SURFACE AREA, 2.0' BELOW SUBDRAIN
52	21,864	93.6	0.55	PERVIOUS GUTTER WITH BIORETENTION	750 SF OF SURFACE AREA, 3.4' BELOW SUBDRAIN
53	30,741	98.0	0.50	PERVIOUS GUTTER WITH BIORETENTION	1,400 SF OF SURFACE AREA, 4.0' BELOW SUBDRAIN
54	17,291	92.3	0.61	PERVIOUS GUTTER WITH BIORETENTION	740 SF OF SURFACE AREA, 2.4' BELOW SUBDRAIN
55	23,221	86.8	0.52	BIORETENTION TYPE A	780 SF OF SURFACE AREA, 1.8' BELOW SUBDRAIN
56	21,403	95.3	0.66	BIORETENTION TYPE A/PERVIOUS GUTTER WITH BIORETENTION	800 SF OF SURFACE AREA, 3.7' BELOW SUBDRAIN
57	19,564	88.2	0.47	BIORETENTION TYPE A	1,090 SF OF SURFACE AREA, 1.3' BELOW SUBDRAIN
58	28,421	94.3	0.61	PERVIOUS GUTTER WITH BIORETENTION	1,074 SF OF SURFACE AREA, 3.4' BELOW SUBDRAIN
59	6,611	95.3	0.66	PERVIOUS GUTTER WITH BIORETENTION	441 SF OF SURFACE AREA, 2.1' BELOW SUBDRAIN
60	2700	98.0	0.70	BIORETENTION TYPE B	100 SF OF SURFACE AREA, 4.9' BELOW SUBDRAIN

Brelje & Race CONSULTING ENGINEERS
475 Aviation Boulevard, Suite 120
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v: 707-576-1322
f: 707-576-0469
www.brce.com

ELNOKA CCRC DESIGN REVIEW

251 ELNOKA LANE
SANTA ROSA, CALIFORNIA

LEGEND

- DMA BOUNDARY
- PERVIOUS GUTTER WITH BIORETENTION
- BIORETENTION PLANTER TYPE A
- BIORETENTION PLANTER TYPE B
- TREEPOD BIORETENTION STRUCTURE
- UNDEGROUND STORMWATER RETENTION STRUCTURE
- APPROXIMATE SOIL TYPE BOUNDARY
- C — SOIL TYPE REFERENCE
- (4) — DMA AREA LABEL

DATE

REVISIONS		
NO.	DATE	DESCRIPTION

ON A FULL-SCALE DRAWING, LENGTH OF BAR BELOW IS 1-INCH. IF BAR MEASURES LESS THAN 1-INCH, THIS SHEET WAS PLOTTED AT A REDUCED SCALE, WHICH MAY REQUIRE ADJUSTMENT OF SCALE(S) SHOWN ON DRAWING.

PROJECT	DATE
–	–
DRAWN BY	CHECKED BY
PIT	–

LID PLAN AND DETAILS

SHEET NO.
1 OF 6

SEE SHEET 5

SEE SHEET 3

SEE SHEET 1

BUILDING F

BUILDING E

BUILDING B

CARE CENTER

60 (TYP.)

BIORETENTION PLANTER(TYP.)

PERVIOUS GUTTER WITH BIORETENTION (TYP)

12" SD

8" SD

24" SD

CONNECT TO EX STORM DRAIN

SCALE IN FEET
1" = 30 FT.

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PROJECT	DATE
–	–
DRAWN BY	CHECKED BY
PIT	–

LID PLAN

SHEET NO.
2 OF **6**

398

SEE SHEET 6

SEE SHEET 2

SEE SHEET 4

TAB: 3

BUILDING D

MELITA CREEK

SOUTH FORK MELITA CREEK

BIORETENTION PLANTER(TYP.)

PERVIOUS GUTTER WITH BIORETENTION (TYP)

CONNECT TO EX STORM DRAIN (TYP)

EX STORM DRAIN TO REMAIN (TYP)

PROPOSED ARCH CULVERT OVER MELITA CREEK

SCALE IN FEET
1" = 30 Ft.

SCALE IN FEET
1" = 30 Ft.

C

D

D

B

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LID PLAN

SHEET NO.
3 OF **6**

399

DMA AREA #	TOTAL AREA (sf)	CN POST	C POST	PROPOSED BMP TYPE	PROPOSED BMP SIZE
1	20,850	94.2	0.60	BIORETENTION TYPE A	600 SF OF SURFACE AREA, 4.3' BELOW SUBDRAIN
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3	48,548	93.6	0.59	BIORETENTION TYPE A	1,555 SF OF SURFACE AREA, 3.7' BELOW SUBDRAIN
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6	25,625	90.4	0.51	BIORETENTION TYPE A	880 SF OF SURFACE AREA, 2.5' BELOW SUBDRAIN
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23	23,920	95.6	0.62	PERVIOUS GUTTER WITH BIORETENTION	1,128 SF OF SURFACE AREA, 3.1 BELOW SUBDRAIN
24	34,991	92.9	0.53	PERVIOUS GUTTER WITH BIORETENTION	1,370 SF OF SURFACE AREA, 2.8 BELOW SUBDRAIN
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33	7,412	93.8	0.63	PERVIOUS GUTTER WITH BIORETENTION	488 SF OF SURFACE AREA, 1.9 BELOW SUBDRAIN
34	30,425	95.4	0.61	PERVIOUS GUTTER WITH BIORETENTION	1,540 SF OF SURFACE AREA, 2.8 BELOW SUBDRAIN
35	44,444	94.8	0.60	PERVIOUS GUTTER WITH BIORETENTION	2,786 SF OF SURFACE AREA, 2.1 BELOW SUBDRAIN
36	45,025	92.8	0.53	PERVIOUS GUTTER WITH BIORETENTION	2,117 SF OF SURFACE AREA, 2.1 BELOW SUBDRAIN
37	24,028	93.8	0.56	PERVIOUS GUTTER WITH BIORETENTION	1,105 SF OF SURFACE AREA, 2.6 BELOW SUBDRAIN
38	22,242	98	0.70	PERVIOUS GUTTER WITH BIORETENTION	1,450 SF OF SURFACE AREA, 2.8 BELOW SUBDRAIN
39	6,898	98	0.70	PERVIOUS GUTTER WITH BIORETENTION	540 SF OF SURFACE AREA, 2.3 BELOW SUBDRAIN
40	35,086	94.6	0.57	TREEPOD WITH UNDERGROUND RETENTION	8'X66'X5.5' DEEP UNDERGROUND RETENTION
41	43,274	91.5	0.60	PERVIOUS GUTTER WITH BIORETENTION	1,670 SF OF SURFACE AREA, 2.5 BELOW SUBDRAIN
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44	27,597	93.5	0.57	TREEPOD WITH UNDERGROUND RETENTION	8'X46'X5.5' DEEP UNDERGROUND RETENTION
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46	24,447	92.3	0.61	BIORETENTION TYPE A	695 SF OF SURFACE AREA, 3.7' BELOW SUBDRAIN
47	14,334	85.6	0.50	BIORETENTION TYPE A	230 SF OF SURFACE AREA, 3.0' BELOW SUBDRAIN
48	19,963	92.2	0.58	PERVIOUS GUTTER WITH BIORETENTION	720 SF OF SURFACE AREA, 2.9' BELOW SUBDRAIN
49	4,087	92.2	0.58	TREEPOD WITH UNDERGROUND RETENTION	4'X12'X5.5' DEEP UNDERGROUND RETENTION
50	46,173	94.5	0.61	TREEPOD WITH UNDERGROUND RETENTION	10'X68'X5.5' DEEP UNDERGROUND RETENTION
51	11,547	92.1	0.58	PERVIOUS GUTTER WITH BIORETENTION	600 SF OF SURFACE AREA, 2.0' BELOW SUBDRAIN
52	21,864	93.6	0.58	PERVIOUS GUTTER WITH BIORETENTION	750 SF OF SURFACE AREA, 3.4' BELOW SUBDRAIN
53	30,741	98.0	0.58	PERVIOUS GUTTER WITH BIORETENTION	1,400 SF OF SURFACE AREA, 4.0' BELOW SUBDRAIN
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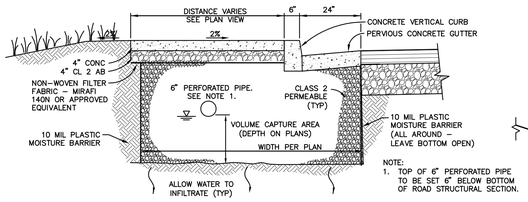
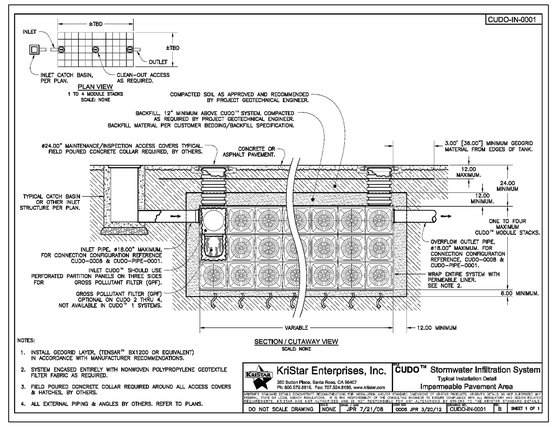


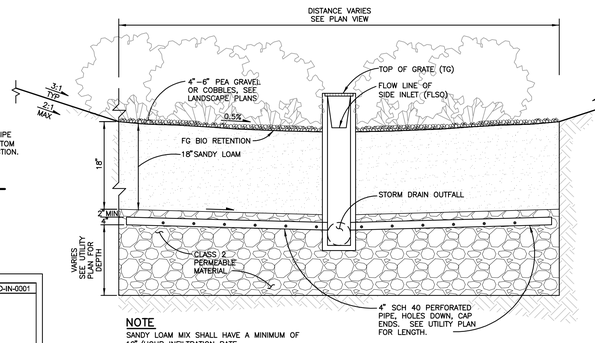
PERVIOUS GUTTER WITH BIORETENTION

NOT TO SCALE



CUDO STORMWATER INFILTRATION SYSTEM

NOT TO SCALE

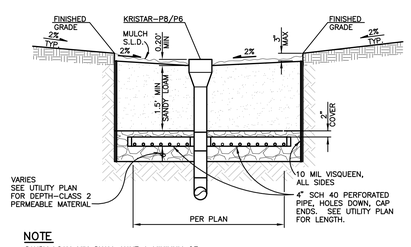


NOTE

SANDY LOAM MIX SHALL HAVE A MINIMUM OF 10"/HOUR INFILTRATION RATE.

BIORETENTION PLANTER TYPE A

NOT TO SCALE

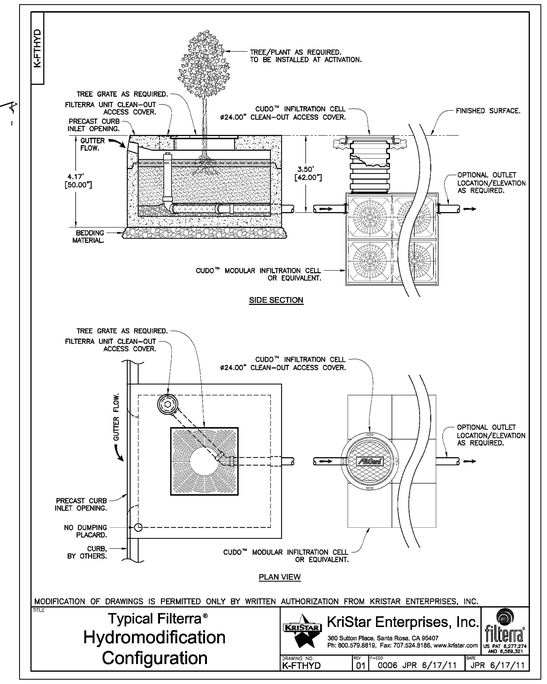


NOTE

SANDY LOAM MIX SHALL HAVE A MINIMUM OF 10"/HOUR INFILTRATION RATE.

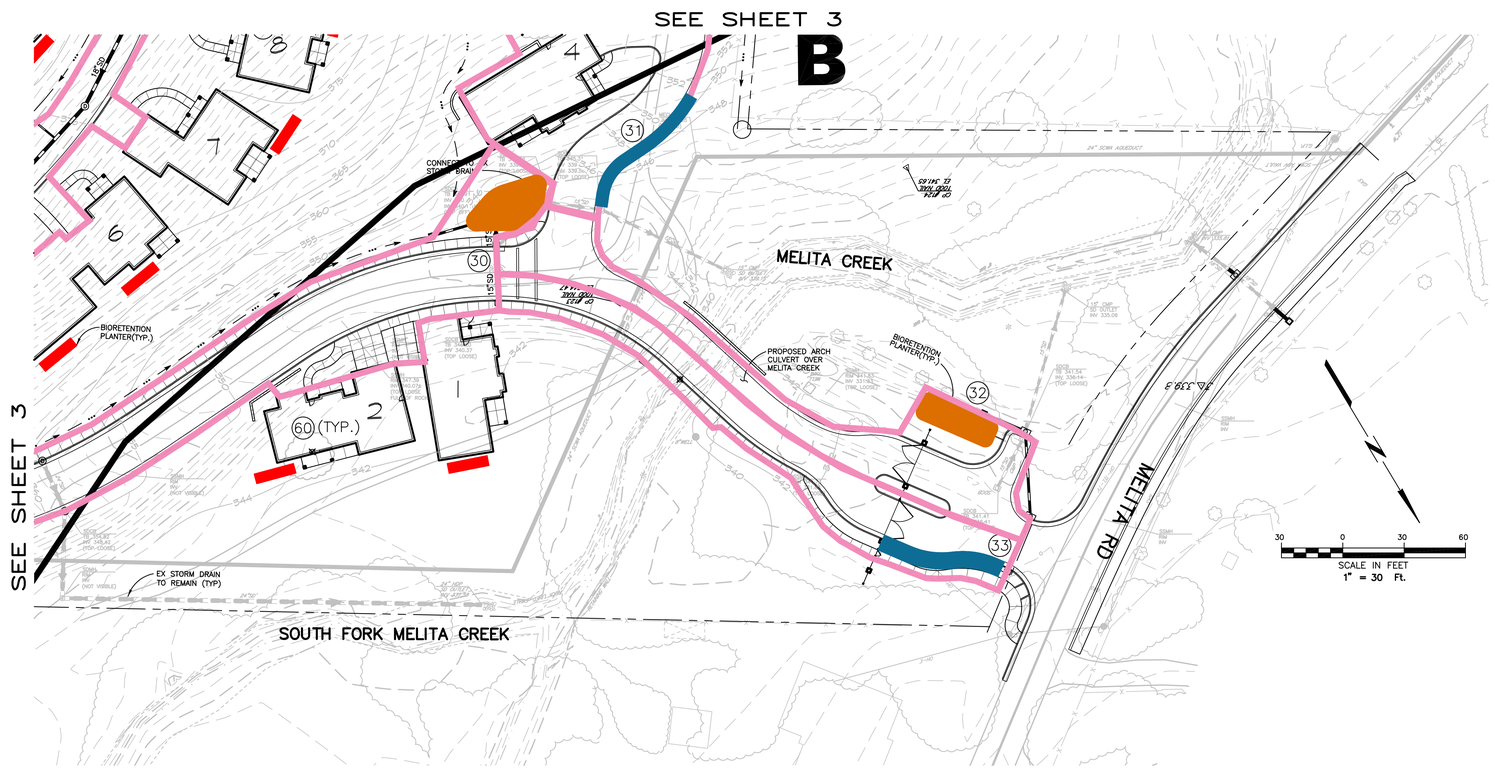
BIOINFILTRATION PLANTER TYPE B

NOT TO SCALE



TREEPOD BIORETENTION STRUCTURE

NOT TO SCALE



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DATE

REVISIONS

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PROJECT	DATE
–	–
DRAWN BY	CHECKED BY
PIT	–

LID PLAN AND DETAILS

SHEET NO.

4 OF 6

400

CHANNEL DRIVE

ANNADEL CREEK

OAKMONT CREEK

OAKMONT CREEK

BUILDING P

BUILDING N

BUILDING M

BUILDING H

BUILDING G

PERVIOUS GUTTER WITH BIORETENTION

BIORETENTION PLANTER(TYP.)

BIORETENTION PLANTER(TYP.)

UNDERGROUND RETENTION

UNDERGROUND RETENTION

PROPOSED ARCH CULVERT OVER OAKMONT CREEK

12"SD

15"SD

18"SD

10"SD

8"SD

24"SD

60 (TYP.)

SCALE IN FEET
1" = 30 Ft.

SEE SHEET 6

SEE SHEET 2

Brelje & Race CONSULTING ENGINEERS
475 Aviation Boulevard, Suite 120
Santa Rosa, CA 95403
v: 707-576-1322
f: 707-576-0469
www.brce.com

ELNOKA CCRC DESIGN REVIEW

251 ELNOKA LANE
SANTA ROSA, CALIFORNIA

LEGEND

- DMA BOUNDARY
- PERVIOUS GUTTER WITH BIORETENTION
- BIORETENTION PLANTER TYPE A
- BIORETENTION PLANTER TYPE B
- TREEPOD BIORETENTION STRUCTURE
- UNDEGROUND STORMWATER RETENTION STRUCTURE
- APPROXIMATE SOIL TYPE BOUNDARY
- C — SOIL TYPE REFERENCE
- (4) — DMA AREA LABEL

DATE

REVISIONS		
NO.	DATE	DESCRIPTION

ON A FULL-SCALE DRAWING, LENGTH OF BAR BELOW IS 1-INCH. IF BAR MEASURES LESS THAN 1-INCH, THIS SHEET WAS PLOTTED AT A REDUCED SCALE, WHICH MAY REQUIRE ADJUSTMENT OF SCALE(S) SHOWN ON DRAWING.

PROJECT	DATE
–	–
DRAWN BY	CHECKED BY
PIT	–

LID PLAN

SHEET NO.
5 OF 6

401

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475 Aviation Boulevard, Suite 120
Santa Rosa, CA 95403
v: 707-576-1322
f: 707-576-0469
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REVISIONS

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PROJECT	DATE
–	–
DRAWN BY	CHECKED BY
	–

LID PLAN

SHEET NO.
6 OF 6

SEE SHEET 5

SEE SHEET 3

CHANNEL DRIVE

OAKMONT CREEK

BUILDING I

BUILDING J

BUILDING K

C

B

C

B

C

(45) (46) (47) (48) (49) (50)

60 (TYP.)

BIORETENTION PLANTER(TYP.)

UNDERGROUND RETENTION

12" SD

15" SD

6" SD

SCALE IN FEET
1" = 30 Ft.

K.2 - Water Supply Assessment for Santa Rosa General Plan 2035

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SB 610 Water Supply Assessment

For

Santa Rosa General Plan 2035

November 25, 2008

City of
Santa Rosa
Utilities Department

Acronyms

AF - Acre-feet
AFY – Acre-feet per year
BMP – Best Management Practice
CDFG – California Department of Fish and Game
CEQA – California Environmental Quality Act
CFR – Code of Federal Regulations
CFS – Cubic Feet per Second
COE – Corps of Engineers
CUWCC – California Urban Water Conservation Council
DPH – Department of Public Health
DOI – Department of Interior
DWR – Department of Water Resources
EIR – Environmental Impact Report
EIS – Environmental Impact Statement
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FERC – Federal Energy Regulatory Commission
GPM – Gallons per minute
IRWP – Incremental Recycled Water Program
MGD – Million gallons per day
MOU – Memorandum of Understanding
NMFS – National Marine Fisheries Service
PG&E – Pacific Gas and Electric Company
PVP – Potter Valley Project
REF – Residential Equivalency Factor
RPA – Reasonable and Prudent Alternative
RPM – Reasonable and Prudent Measures
SB – Senate Bill
SCWA – Sonoma County Water Agency
SF – Square feet
SWRCB – State Water Resources Control Board
USFWA – United States Fish and Wildlife Service
USGS – United States Geological Survey
UWMP – Urban Water Management Plan
WSA – Water Supply Assessment
WSTSP – Water Supply and Transmission System Project

Water Supply Assessment
for
Santa Rosa General Plan 2035

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1 EXECUTIVE SUMMARY

Senate Bill 610 of 2001 (SB 610) requires that water suppliers provide a Water Supply Assessment (WSA) to planning agencies for any proposed projects which are subject to the California Environmental Quality Act (CEQA) and would demand an amount of water equivalent to or greater than the amount of water required by a 500 dwelling unit project. The proposed Santa Rosa General Plan 2035 (Project) is subject to CEQA and has an increase in the number of residential dwelling units over the current General Plan (General Plan 2020) of approximately 4,000 units, so it is subject to SB 610. The City of Santa Rosa (City) is both the public water system and land use planning agency for the Project.

A WSA addresses the current and planned future water demand of the water supplier, the projected demand of the proposed project, the projected water supply of the water supplier, and makes a determination of the sufficiency of its water supplies for the project, in addition to the existing and planned future uses. The Project that is the subject of this WSA deals only with the change in development from General Plan 2020 to the proposed General Plan 2035. Therefore, the Project water demand analyzed in this WSA is the increment of increased demand from General Plan 2020 to the Project.

SB 610 requires the water supplier to analyze total projected water supply sufficiency for twenty (20) years following the request for the WSA, which for this WSA is through 2028. Although this Project updates the General Plan through the horizon year of 2035, for purposes of this WSA, it is anticipated that the entire Project water demand would occur by 2028.

As set forth in this WSA, the water demand for the Project is projected to be a maximum of 1,040 acre-feet per year (afy). The density and land use of the Project have been defined as part of the Project.

The WSA concludes that the City's projected water supplies, consisting of existing and additional water supplies, are sufficient to meet the projected water demand associated with the Project, in addition to current and planned future uses, for the 20 year projection.

A combination of existing and additional sources comprises the City's projected water supply for the water demand projected for the Project. The primary source of supply is contractual entitlement from SCWA as defined in the Restructured Agreement for Water Supply. Water supply is also provided from Santa Rosa's groundwater sources and recycled water sources. The current existing supplies are projected to meet all demands through approximately 2018, or through 2015 if the City, through discretionary action, connects a significant number of water services that are now served by private wells.

The City's additional water supply will be met from the 3,000 afy recycled water project, which is ready to implement when needed, and the following sources which are all under evaluation or development: additional entitlement from SCWA, additional local groundwater, additional recycled water beyond the 3,000 afy project, and/or more stringent conservation measures.

Therefore, for any part of the Project developed after 2018 (or after 2015 with the above stated conditions), the demand may be met with the existing SCWA supply

source and local groundwater supply sources, or it may be met with any of the additional water supplies –the 3,000 afy recycled water project, additional entitlement from SCWA, additional local groundwater, additional recycled water or more stringent conservation measures.

2 ASSESSMENT

2.1 Introduction

California Water Code:
10910. (a) Any city or county that determines that a project, as defined in Section 10912, is subject to the California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) under Section 21080 of the Public Resources Code shall comply with this part.

10914. (a) Nothing in this part is intended to create a right or entitlement to water service or any specific level of water service.
(b) Nothing in this part is intended to either impose, expand, or limit any duty concerning the obligation of a public water system to provide certain service to its existing customers or to any future potential customers.
(c) Nothing in this part is intended to modify or otherwise change existing law with respect to projects which are not subject to this part.
(d) This part applies only to a project for which a notice of preparation is submitted on or after January 1, 1996.

The City has prepared this WSA for the Project pursuant to California Water Code (Code) sections 10910-10915 as required by SB 610. To increase the accessibility of the information presented herein, each section of the WSA that responds directly to a requirement of the Code begins with a recitation of the applicable language from the pertinent Code provisions, which are addressed in that section of the WSA.

The purpose of this WSA is to perform the evaluation required by SB 610 in connection with the Project. It is not to reserve water, or to function as a "will serve" letter or any other form of commitment to supply water (per Water Code section 10914). The provision of water service will continue to be undertaken in a manner consistent with applicable City policies and procedures, consistent with existing law.

In accordance with SB 610, this WSA evaluates projected supply and demand for a twenty-year period, or until 2028. Although this Project updates the General Plan through the horizon year of 2035, for purposes of this WSA, it is anticipated that the entire Project water demand would occur by 2028. Because the City Urban Water Management Plan (City 2005 UWMP) includes supply and demand projections through 2030, where the City 2005 UWMP is the source of information, data through 2030 is presented in this WSA.

2.2 Applicability

2.2.1 When a WSA is Required

California Water Code:
10910. (a) Any city or county that determines that a project, as defined in Section 10912, is subject to the California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) under Section 21080 of the Public Resources Code shall comply with this part.

10912. For the purposes of this part, the following terms have the following meanings:
(a) "Project" means any of the following:
(1) A proposed residential development of more than 500 dwelling units.
(2) A proposed shopping center or business establishment employing more than 1,000 persons or having more than 500,000 square feet of floor space.
(3) A proposed commercial office building employing more than 1,000 persons or having more than 250,000 square feet of floor space.
(4) A proposed hotel or motel, or both, having more than 500 rooms.
(5) A proposed industrial, manufacturing, or processing plant, or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area.
(6) A mixed-use project that includes one or more of the projects specified in this subdivision.

(7) A project that would demand an amount of water equivalent to, or greater than, the amount of water required by a 500 dwelling unit project.

(b) If a public water system has fewer than 5,000 service connections, then "project" means any proposed residential, business, commercial, hotel or motel, or industrial development that would account for an increase of 10 percent or more in the number of the public water system's existing service connections, or a mixed-use project that would demand an amount of water equivalent to, or greater than, the amount of water required by residential development that would represent an increase of 10 percent or more in the number of the public water system's existing service connections. (See also 14 Cal. Code Regs. § 15155, sub. (a)(1).)

The Project is entitled the Santa Rosa General Plan 2035. The City has determined that the Project is subject to CEQA. As shown in Table 1, it includes the following net increase or decrease of development when compared with the prior General Plan 2020:

Table 1 – Proposed Project Development

Category	Units	Square Feet
Detached residential	3,396	N/A
Attached residential	600	N/A
Office space	N/A	237,697
Retail/commercial	N/A	(2,447,468)
Light/general industrial	N/A	1,513,806
Public/institutional development	N/A	(93,561)
Park or public landscaped area	N/A	217,800
Total	**3,996**	**(571,726)**

Since the Project is subject to CEQA and includes development that meets or exceeds the criteria set forth in Water Code section 10912(a), it qualifies as a "project" and is subject to the requirements of SB 610.

2.2.2 Public Water System Identified

10910. (b) The city or county, at the time that it determines whether an environmental impact report, a negative declaration, or a mitigated negative declaration is required for any project subject to the California Environmental Quality Act pursuant to Section 21080.1 of the Public Resources Code, shall identify any water system that is, or may become as a result of supplying water to the project identified pursuant to this subdivision, a public water system, as defined in Section 10912, that may supply water for the project. If the city or county is not able to identify any public water system that may supply water for the project, the city or county shall prepare the water assessment required by this part after consulting with any entity serving domestic water supplies whose service area includes the project site, the local agency formation commission, and any public water system adjacent to the project site.

10912 (c) "Public water system" means a system for the provision of piped water to the public for human consumption that has 3000 or more service connections. A public water system includes all of the following:

(1) Any collection, treatment, storage, and distribution facility under control of the operator of the system which is used primarily in connection with the system.

(2) Any collection or pretreatment storage facility not under the control of the operator that is used primarily in connection with the system.

(3) Any person who treats water on behalf of one or more public water systems for the purpose of rendering it safe for human consumption.

The City of Santa Rosa Utilities Department operates the public water system that provides water supply to the Project area. The City also owns and operates the Subregional Water Reclamation System (Subregional System), which provides recycled water to the Project area.

2.2.3 Requirement for Submittal of Assessment

10910. (g) (1) Subject to paragraph (2), the governing body of each public water system shall submit the assessment to the city or county not later than 90 days from the date on which the request was received. The governing body of each public water system, or the city or county if either is required to comply with this act pursuant to subdivision (b), shall approve the assessment prepared pursuant to this section at a regular or special meeting.

(2) Prior to the expiration of the 90-day period, if the public water system intends to request an extension of time to prepare and adopt the assessment, the public water system shall meet with the city or county to request an extension of time, which shall not exceed 30 days, to prepare and adopt the assessment.

(3) If the public water system fails to request an extension of time, or fails to submit the assessment notwithstanding the extension of time granted pursuant to paragraph (2), the city or county may seek a writ of mandamus to compel the governing body of the public water system to comply with the requirements of this part relating to the submission of the water supply assessment.

10910. (h) Notwithstanding any other provision of this part, if a project has been the subject of a water supply assessment that complies with the requirements of this part, no additional water supply assessment shall be required for subsequent projects that were part of a larger project for which a water supply assessment was completed and that has complied with the requirements of this part and for which the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), has concluded that its water supplies are sufficient to meet the projected water demand associated with the proposed project, in addition to the existing and planned future uses, including, but not limited to, agricultural and industrial uses, unless one or more of the following changes occurs:

(1) Changes in the project that result in a substantial increase in water demand for the project.

(2) Changes in the circumstances or conditions substantially affecting the ability of the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), to provide a sufficient supply of water for the project.

(3) Significant new information becomes available which was not known and could not have been known at the time when the assessment was prepared.

The Project has not been the subject of a previous WSA, nor has it been part of a larger project for which a WSA was completed.

The City of Santa Rosa Advanced Planning and Public Policy Division (Advanced Planning) of the City Manager's Office is the land use planning agency for the Project. Advanced Planning made a request of the City Utilities Department to prepare this WSA for the Project on August 13, 2008. This WSA was approved by Resolution of the Santa Rosa City Council on ___November 25, 2008___.

2.2.4 Project Description

The Project is described in full in the Santa Rosa General Plan 2035 Draft Environmental Impact Report. A brief description of the Project and a location map follows.

The Project encompasses the Santa Rosa Urban Growth Boundary (UGB) area, which includes approximately 29,100 acres, or slightly more than 45 square miles. The UGB contains the City of Santa Rosa and unincorporated land that will eventually be annexed and served by the City as illustrated generally in Figure 1. As detailed in section 2.2.1 of this WSA, the Project includes residential, office space, retail/commercial, light/general industrial, public/institutional, and park or public landscaped area development.

The Project is a focused update of Santa Rosa's General Plan, which was last updated in 2002. This update focuses on the Housing Element and will incorporate policies of recent planning documents and new policies regarding climate protection in a document with a horizon year of 2035.

General Plan Land Use Diagram

- Country Residential (0.05-0.2 units per acre)
- Very Low Densitiy Residential (0.2-2.0 units per acre)
- Low Density/Open Space (2.0-8.0 units per acre)
- Low Density Residential (2.0-8.0 units per acre)
- Medium Low Density Residential (8.0-13.0 units per acre)
- Medium Density Residential (8.0-18.0 units per acre)
- Medium High Density Residential (18.0-30.0 units per acre)
- Transit Village Medium (25.0-40.0 units per acre)
- Mobile Homes (4.0-18.0 units per acre)
- Transit Village Mixed Use
- Retail & Business Services
- Office
- Business Park
- Light Industry
- General Industry
- Public/Institutional
- Parks and Recreation
- Open Space
- Agriculture
- Potential Wetlands and RarePlants (Subject to Federal and State Agency Clearance)

Notes: 1. Densities are housing units/gross acre

2. Stripes indicate areas designated for multiple land uses. Single use or a mix of uses is permitted.

Existing / Proposed

- Elementary School
- Middle School
- High School
- Neighborhood Park
- Community Park
- Community Shopping Center
- Neighborhood Shopping Center
- Resort

- Station Area Plan
  * See Downtown Station Area Specific Plan
- Area Not to be Developed Prior to 2010
- Planning Area
- Urban Growth Boundary

Existing/Proposed

- Highway
- Regional/Arterial Street
- Transitional/Collector Street
- Conceptual Local Street
- Highway Interchange

CITY OF SANTA ROSA

Amended October 9, 2007

The Project includes a mix of residential, retail, office, industrial and public uses. While the number of residential units has increased over the prior General Plan by approximately 4,000 units, the square footage of non-residential uses remains relatively stable. It is assumed that vacant lands will develop over the next 25 plus years and that some redevelopment will also occur, especially within the boundaries of the Downtown Station Area Specific Plan.

As noted above, major policies from documents which have been recently adopted (or are expected to be soon adopted) will be included in the Project. Concepts will be included from the following documents:

- Northern Downtown Pedestrian Linkages Program
- Downtown Station Area Specific Plan
- Sebastopol Road Urban Vision and Corridor Plan
- Vision 2030
- Citywide Creek Master Plan
- Southeast Area Plan
- Southwest Area Plan
- Economic Development Strategy, Phase 2
- Recreation and Parks Business and Strategic Plan
- Bicycle and Pedestrian Master Plan
- Local Hazard Mitigation Plan

The Project deals only with the change in development from the General Plan 2020 to the proposed General Plan 2035. Therefore, the Project water demand analyzed in this WSA is the increment of increased projected water demand from that described in the General Plan 2020 to the Project.

2.3 Urban Water Management Plan and Other Resources

10910 (c) (1) The city or county, at the time it makes the determination required under Section 21080.1 of the Public Resources Code, shall request each public water system identified pursuant to subdivision (b) to determine whether the projected water demand associated with a proposed project was included as part of the most recently adopted urban water management plan adopted pursuant to Part 2.6 (commencing with Section 10610).
(2) If the projected water demand associated with the proposed project was accounted for in the most recently adopted urban water management plan, the public water system may incorporate the requested information from the urban water management plan in preparing the elements of the assessment required to comply with subdivisions (d), (e), (f), and (g).

In accordance with the California Urban Water Management Planning Act (Act), the City adopted its 2005 Urban Water Management Plan (City 2005 UWMP) on June 27, 2006. As required by the Act, the City 2005 UWMP includes projected water supplies required to meet future demands. Though the Act only required supply and demand projections through 2025, the City 2005 UWMP provides projections through 2030. Information from the City 2005 UWMP is the basis for the elements of this WSA addressing demands and supplies from all sources of water.

The demand projections in the City 2005 UWMP were based on an analysis performed by the regional wholesale water provider, SCWA (SCWA Demand Projections)[1]. SCWA Demand Projections for the City are for water supply for normal

[1] See Appendix B to City of Santa Rosa 2005 Urban Water Management Plan entitled "Revised Customer Water Demand

weather conditions. Demand projections for discretionary water service were developed for the City in 2002 in the *City of Santa Rosa Water Supply Analysis* (West Yost Associates, 2002), hereafter Supply Analysis. Information from the Supply Analysis is also provided in the demand projection portion of the WSA.

The City 2005 UWMP included demand projections through buildout of the City's current General Plan. The demand projection for the Project is for development beyond the buildout horizon of the current General Plan. Although the Project demand projection of 1,040 afy was not specifically included in the City's 2005 UWMP, the City 2005 UWMP demand projection includes up to 2,000 afy of demand which the City has discretion to serve. Therefore, the City demand projection in the 2005 UWMP could be used to serve the Project.

The City 2005 UWMP supply projections are the basis for the supply assessment in this WSA. These supply projections are based on both the City 2005 UWMP and the Supply Analysis. The City 2005 UWMP supply projections reflect planning for both the 2,000 afy of discretionary demand and supply for hot, dry non-drought years. The City 2005 UWMP supply projection includes 2,000 afy to serve demands that the City has the discretion to serve and which could be used to serve this Project.

The City 2005 UWMP single and multiple dry year supply analysis and the SCWA 2005 Urban Water Management Plan, which was adopted December 2006, (SCWA 2005 UWMP) are the sources for the dry year evaluations of this WSA[2].

2.4 Existing Supplies

10910. (d) (1) The assessment required by this section shall include an identification of any existing water supply entitlements, water rights, or water service contracts relevant to the identified water supply for the proposed project, and a description of the quantities of water received in prior years by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), under the existing water supply entitlements, water rights, or water service contracts.

(2) An identification of existing water supply entitlements, water rights, or water service contracts held by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), shall be demonstrated by providing information related to all of the following:

(A) Written contracts or other proof of entitlement to an identified water supply.

(B) Copies of a capital outlay program for financing the delivery of a water supply that has been adopted by the public water system.

(C) Federal, state, and local permits for construction of necessary infrastructure associated with delivering the water supply.

(D) Any necessary regulatory approvals that are required in order to be able to convey or deliver the water supply.

2.4.1 Water Supply Overview

The City currently has three sources of existing water supply which serve the Project area: 29,100 afy entitlement from SCWA; 2,300 afy groundwater from the City's wells; and approximately 410 afy recycled water (current use of approximately 350 afy plus 60 afy from first phase of expanded urban reuse) from the City's Subregional System. In addition, the City has a very aggressive water conservation program which

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Projections Summary of Data Inputs, Assumptions and Results," dated November 3, 2005.

[2] The approval of the SCWA 2005 Urban Water Management Plan was vacated by the Sonoma County Superior Court on October 28, 2008, and the Plan was remanded to SCWA on other grounds not affecting the validity of the dry year analysis.

provides supply through reducing current demands and assuring that future demands are efficient.

Santa Rosa currently receives the majority of its potable water supply from SCWA under the provisions of the Restructured Agreement for Water Supply (Restructured Agreement), which was executed in June 2006; approximately 95% of water delivered by SCWA is from surface water sources, with the remainder from groundwater. Section 2.5.1.1 of this WSA describes potential additional supply from SCWA.

In addition to SCWA supply, in July 2005, the City received permission from the California Department of Public Health (DPH) to use two of its groundwater wells, formally permitted as standby emergency wells, for supply; this supply source is now permitted for regular production and can provide up to 2,300 afy to the City. Section 2.5.1.2 of this WSA describes potential additional groundwater supply.

The City is also the owner and operator of the Subregional System, which produces recycled water. The City has historically used approximately 350 afy of recycled water for landscape irrigation and has up to 6,600 afy of additional recycled supply available which can be developed to serve the Project area. Section 2.5.1.3 discusses development of this additional recycled water in detail.

The following discussion sections describe the existing supply sources: SCWA contractual entitlement, City groundwater, recycled water, and water conservation. Depending on the timing of Project development, supply for the Project will be met with existing supplies and any mix of the additional sources described in Section 2.5.

2.4.2 Existing Wholesale Water Supply – SCWA

The City currently receives the majority of its potable water supply from SCWA. SCWA is authorized to produce and deliver potable water for municipal and industrial purposes; prevent the waste or diminution of water supplies; control and conserve flood and storm waters to reduce potential damage to life and property; provide sanitary sewage services; and provide recreational services in connection with flood control and water conservation activities. SCWA operates under direction of a Board of Directors that consists of the Sonoma County Board of Supervisors.

SCWA delivers water, on a wholesale basis, to customers through its water transmission system. The primary water customers, collectively known as the water contractors, consist of the cities of Santa Rosa, Rohnert Park, Petaluma, Cotati, and Sonoma; the Town of Windsor; and the North Marin, and Valley of the Moon Water Districts. The responsibility for supplying water to the water contractors is entrusted to SCWA under the Restructured Agreement, which was executed in June 2006. SCWA also provides water on a wholesale basis to and/or has authorized the exercise of its water rights by additional water purveyors, including but not limited to Marin Municipal Water District; the Forestville Water District; and California-American, Lawndale Mutual, Penngrove, and Kenwood Water Companies.

SCWA's primary source of supply is the Russian River. Water is collected from the Russian River at two sites, both located near Forestville, through three Ranney collectors at Wohler and three Ranney collectors at Mirabel, plus seven production wells at Mirabel. SCWA has constructed several infiltration ponds that surround the collectors.

An inflatable dam on the Russian River raises the water level of the Russian River during periods of low flow, and diverts water through a dike into a system of ditches that supply the infiltration ponds that surround the Mirabel collectors. The backwater created by the dam also raises the upstream water level, which increases the rate of infiltration to the Wohler collectors. Permanent fish ladders provide fish passage around the dam when it is raised.

SCWA holds appropriative water rights to Russian River and Dry Creek water by virtue of an assignment to SCWA of Sonoma County's portion of the 1949 application to the State of California for the Coyote Valley Dam Project appropriative water rights, and SCWA's 1960 application for the Warm Springs Dam Project appropriative water rights. The combined water supply storage from these two projects exceeds 300,000 afy. The combined limit on SCWA's annual Russian River diversions under its water rights permits (Permit Nos. 12947A, 12949, 12950, and 16596) is currently 75,000 afy, with a maximum diversion rate of 180 cubic feet per second. In 2002, SCWA reported approximately 64,000 afy of diversion and use under these water rights permits**.**

SCWA also has three deep-water wells that provide water supply. They are located near the Laguna de Santa Rosa and feed directly into SCWA's Russian River-Cotati Intertie Pipeline. The SCWA estimates the production capacity of these wells at 3,870 afy. Further discussion of SCWA groundwater is in Section 2.4.4.2.5 of this WSA.

2.4.3 Conditions Which Could Affect SCWA Supply

The following conditions, discussed in detail below, could affect the City's long-term sustainable water supply available from SCWA:

- Completion of SCWA's Water Project EIR;
- Section 7 consultation and Biological Opinion:
- Future operation of the Potter Valley Project;
- Temporary Impairment Condition.

Completion of Water Project EIR: In 1998, SCWA's Board of Directors certified an environmental impact report (EIR) for the SCWA Water Supply and Transmission System Project (WSTSP) and approved the project. The objective of the WSTSP was to provide a safe, economical and reliable water supply to meet the defined future needs of SCWA's service area, which includes providing for the future water supply needs of the City. The WSTSP was expected to increase the amount of water SCWA diverts from the Russian River to 101,000 afy and increase SCWA's water transmission system average-day peak month delivery capacity from 92 to 149 million gallons per day (mgd).

In 1999, a lawsuit was filed challenging the WSTSP EIR. In 2000, the trial court found the EIR to be adequate. However, on May 16, 2003, the Court of Appeals reversed the trial court's decision, concluding that the EIR was inadequate because it did not contain adequate cumulative impacts and alternatives analyses, and its description of the project's environmental setting was deficient. On November 9, 2004 the SCWA adopted a resolution directing the preparation of a new EIR, the Water Supply, Transmission, and Reliability Project EIR (Water Project EIR) to address the inadequacies of the WSTSP EIR and to more closely reflect current water supply circumstances. The draft Water Project EIR was expected to be released for public

review in June 2008. On June 24, 2008, the SCWA Board of Directors adopted Resolution No. 08-0592 directing the SCWA General Manager to delay finalization of the draft Water Project EIR and to schedule an agenda item for Board discussion in October 2008 to consider the timing of the release of the draft Water Project EIR, pending the adoption of the County of Sonoma's General Plan and the release of the National Marine Fisheries Service (NMFS) Biological Opinion for the SCWA's existing water supply and flood control operations . (Resolution No. 08-0592 of the Board of Directors of the Sonoma County Water Agency, June 24, 2008). On September 23, 2008, the Sonoma County Board of Supervisors adopted the Sonoma County General Plan 2020 and on September 24, 2008, NMFS released the *Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed* (Biological Opinion). SCWA is planning to release the draft Water Project EIR by the end of 2008.[3]

Due to the delays in completion of the Water Project, SCWA sent a letter to its contractors, customers, and water diverters reporting under the SCWA Russian River water rights permits on August 11, 2003. The letter stated that due to the 2003 decision of the Court of Appeals, it would be inappropriate for water suppliers to anticipate water deliveries based on diversions of 101,000 afy, or to rely on the delivery estimates of the SCWA 2000 Urban Water Management Plan, which was adopted in 2001 (SCWA 2000 UWMP). The letter further stated that SCWA diverted 63,841 afy in 2002 under their current secure rights to 75,000 afy. Though diversion under these water rights is significantly below the limit, it is possible that diversions will reach 75,000 afy before SCWA is able to secure further diversion rights. If demand exceeds 75,000 afy, taking into account other local supplies available to contractors, before those filings are approved, water supply reductions will be administered in accordance with applicable contract provisions or other arrangements where applicable. For the City and the other parties to the Restructured Agreement, the shortage provisions are defined in section 3.5 of that agreement, and further defined in the Water Shortage Allocation Methodology (John O. Nelson, April 2006; hereafter, Shortage Methodology), which was adopted by the SCWA Board in April 2006. The Restructured Agreement section 3.5 provisions, and the Shortage Methodology, are designed to take the demand hardening associated with water conservation into account. The City implemented an aggressive water conservation program over the past 17 years and has one of the lowest per capita water uses among all SCWA water contractors. Under the Shortage Methodology, if SCWA surface water rights and Russian River supply remain limited to 75,000 afy for some time, and the water contractors' demands reach their maximum entitlement from SCWA, the City's allocation would be 29,100 afy, the full entitlement of the Restructured Agreement. (Letter from Sonoma County, April 2006)

Section 7 Consultation and Biological Opinion. On October 31, 1996, the NMFS published a final notice of determination listing Coho Salmon as threatened and under the federal Endangered Species Act (ESA) within the Central California Coast Evolutionarily Significant Unit (ESU), which includes the Russian River. On August 18,

[3] Communication with Erica Phelps, Sonoma County Water Agency, October 21, 2008.

1997, NMFS published a final notice of determination listing steelhead as threatened under the ESA within the Central California Coast ESU, also including the Russian River. On September 16, 1999, NMFS listed the California Coast ESU of Chinook Salmon as threatened.

In accordance with Section 7(a) (2) of the ESA, federal agencies must consult with the U.S. Fish and Wildlife Service (USFWS) and/or NMFS (depending on the species) to "insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat…." (50 CFR §402). The operation of Warm Springs and Coyote Valley dams and SCWA's rubber dam and fish screens all fall within the provisions of Section 7. Operation of facilities provided in SCWA's proposed WSTSP is also subject to Section 7 consultation.

In December 1997, the Corps of Engineers (COE), as the federal sponsor of the above two flood control and water supply projects, and SCWA, as the local sponsor, entered into a Memorandum of Understanding (MOU) with NMFS to begin the Section 7 consultation process. As part of the Section 7 consultation, a Biological Assessment was prepared to study the impact of current and potential future operations of facilities on the listed species in the Russian River. The final Biological Assessment was completed in September 2004.

As part of the Section 7 consultation process, the NMFS formed Biological Review Teams to conduct a status review of the three listed fish species by assembling the best available information on the condition of the fish species and quantifying risks faced by each ESU. Using the results of the status review, NMFS reevaluated the listing of the three fish species. On June 28, 2005, NMFS issued a final rule confirming the endangered status of the Coho Salmon and maintaining the threatened status of California Coast Chinook Salmon. On January 5, 2006, NMFS issued a final determination listing the steelhead as threatened[4].

On September 24, 2008, NMFS issued the Biological Opinion. The Biological Opinion analyzed the impacts of the current operation of the Warm Springs and Coyote Valley Dams as well as other facilities operated by the COE, SCWA, and the Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed for the next fifteen years. The Biological Opinion determined that the continued operation of some aspects of the flood control and water supply operations will have substantial adverse effects on both the coho salmon and steelhead, but are not likely to effect the survival and recovery of the Chinook salmon in the Russian River. The three areas of most concern are the high summertime flows in the Russian River and Dry Creek, the high velocity of water in Dry Creek in the summer, and the current practice of breaching the sandbar at the estuary during the summer months.[5]

NMFS collaborated with the COE and SCWA to develop a Reasonable and Prudent Alternative (RPA), including eight Reasonable and Prudent Measures (RPMs), to implement over a 15 year timeframe to avoid jeopardy to the coho salmon and

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[4] National Marine Fisheries Service, Southwest Region; "Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed;" September 24, 2008.

[5] Sonoma County Water Agency "The Biological Opinion: Frequently Asked Questions"

steelhead. The RPMs include the following: interim and permanent changes to the summertime flows in the Russian River and Dry Creek; changing the management of the Jenner estuary; restoring fish habitat along Dry Creek; conducting a feasibility study of constructing a pipeline to deliver water from Lake Sonoma to the mainstem of the Russian River; strengthening and expansion of the existing coho broodstock program; installation of a new back-up water supply pipeline to the Warm Springs Hatchery and construction of additional rearing facilities for the coho broodstock program; and monitoring of habitat and fish in the Russian River, Dry Creek, and the Jenner estuary. The Biological Opinion also provides an Incidental Take Statement for the taking of the coho, steelhead and Chinook that may occur due to the implementation of the continued operations of the flood control and water supply operations and the associated RPMs.

The reduced flows required by the RPMs would provide enough water for the SCWA to meet existing water demands. The RPMs provide for restoration of fish habitat in Dry Creek to allow for continued flows to meet the water demands of the SCWA.[6] The habitat restoration in Dry Creek will provide for flows of 130 – 175 cfs in Dry Creek.

SCWA and the COE are currently estimating that the habitat restoration, monitoring and studies will cost up to $100 million over the 15 year period. Funding may come from a variety of sources, including federal and state funds, tax revenues, and funding from water rates.

Future Operation of the Potter Valley Project. From 1908-1999, an estimated 160,000 afy was diverted from the Eel River to the Russian River as a result of the operation of the Pacific Gas & Electric (PG&E) Potter Valley Project (PVP). The Eel River water is diverted through an inter-watershed tunnel to PG&E's hydroelectric facility in Potter Valley. Thereafter, the water was stored in Lake Mendocino and released to augment summer flows and maintain minimum streamflow requirements in the Russian River.

A new license issued by the Federal Energy Regulatory Commission (FERC) to PG&E for the PVP in 1983 required PG&E, in cooperation with the California Department of Fish and Game (CDFG) and USFWS, to carry out a 10-year fish monitoring study in cooperation with NMFS. After completion of the study, a proposed flow schedule reducing Eel River diversions to the Russian River by approximately 15 percent (in an effort to improve Eel River fisheries) was submitted to FERC. PG&E has been voluntarily implementing the recommended flow schedule since the summer of 1999. An Environmental Impact Statement (EIS) that presented the impacts of two proposed flow schedules was released in 1999. Since that time, other proposals have been submitted for FERC's consideration.

In April 1999, as an alternative to the PG&E/FERC proposal, the Department of Interior (DOI)/NMFS jointly submitted a flow proposal which would result in lower PVP imports to the Russian River. In May 2000, FERC issued its final EIS recommending the PG&E flow proposal with PVP Irrigation District modifications. In June 2004, FERC issued its final order on the flow regime based upon a Biological Opinion for the PVP issued by NMFS. The FERC order supports an approximately 15% reduction in summer flows, and is close to the voluntary flow schedule that has been in place since the summer of 1999.

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[6] Sonoma County Water Agency "The Biological Opinion: Frequently Asked Questions"

In August 2006, NMFS and CDFG filed concerns with FERC regarding PG&E's implementation of the flow regime. On October 16, 2006, PG&E sent a letter to FERC acknowledging three errors in implementation of the flow regime and associated flow requirements of the Biological Opinion RPA. In response, PG&E has adjusted implementation of the flow regime.[7] This change has led to an approximately 33% reduction in summer flows. This reflects the current condition of the PVP diversion.[8]

Temporary Impairment Condition: Because of the challenge to the WSTSP and delay in the Water Project EIR, SCWA has not been able to construct certain transmission system components required to meet peak demands. SCWA's Board declared a condition of "temporary impairment" to the transmission system and entered into the "Memorandum of Understanding Regarding Water Transmission System Capacity Allocation during Temporary Impairment" (Transmission System MOU) with all transmission system customers, including the City, initially in 2001 and again in 2006. This MOU affects only transmission system capacity and in no way modifies the annual volume entitlement. The most recent Transmission System MOU expired in September 2008 and parties are in discussion regarding a successor MOU. In absence of an MOU, terms and conditions of the Restructured Agreement apply.

2.4.4 Groundwater

10910. (f) If a water supply for a proposed project includes groundwater, the following additional information shall be included in the water supply assessment:

(1) A review of any information contained in the urban water management plan relevant to the identified water supply for the proposed project.

(2) A description of any groundwater basin or basins from which the proposed project will be supplied. For those basins for which a court or the board has adjudicated the rights to pump groundwater, a copy of the order or decree adopted by the court or the board and a description of the amount of groundwater the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), has the legal right to pump under the order or decree. For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current bulletin of the department that characterizes the condition of the groundwater basin, and a detailed description by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), of the efforts being undertaken in the basin or basins to eliminate the long-term overdraft condition.

(3) A detailed description and analysis of the amount and location of groundwater pumped by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), for the past five years from any groundwater basin from which the proposed project will be supplied. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(4) A detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), from any basin from which the proposed project will be supplied. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(5) An analysis of the sufficiency of the groundwater from the basin or basins from which the proposed project will be supplied to meet the projected water demand associated with the proposed project.

A water supply assessment shall not be required to include the information required by this paragraph if the public water system determines, as part of the review required by paragraph (1), that the sufficiency of groundwater necessary to meet the initial and projected water demand associated with the project was addressed in the description and analysis required by paragraph (4) of subdivision (b) of Section 10631.

Because the water supply for the proposed Project includes groundwater, the following additional information is included in this WSA.

[7] PG&E Letter to FERC, October 16, 2006.

[8] SCWA Letter to PG&E, August 21, 2007.

2.4.4.1 City Groundwater Resources

The City is located within the Santa Rosa Plain sub-basin of the Santa Rosa Valley Groundwater Basin, located at the confluence of the Santa Rosa, Bennett, and Rincon Valleys. Prior to the early 1980s, the City relied primarily on groundwater from this sub-basin for its water supply. In the 1980s SCWA began supplying surface water to the City and other contractors, and by the late 1980s, the City relied solely on purchased surface water deliveries from SCWA to meet its water demands.

2.4.4.1.1 Groundwater Basin Description

As shown on Figure 2, the City UGB overlies portions of two groundwater basins: the Santa Rosa Valley Groundwater Basin (specifically two of its sub-basins: the Santa Rosa Plain Sub-basin and the Rincon Valley Sub-basin) and the Kenwood Valley Groundwater Basin. Characteristics of these groundwater basins and sub-basins are provided in Table 2.

Table 2 – Characteristics of Groundwater Basin/Sub-basins Underlying the City of Santa Rosa Urban Boundary[(a)]

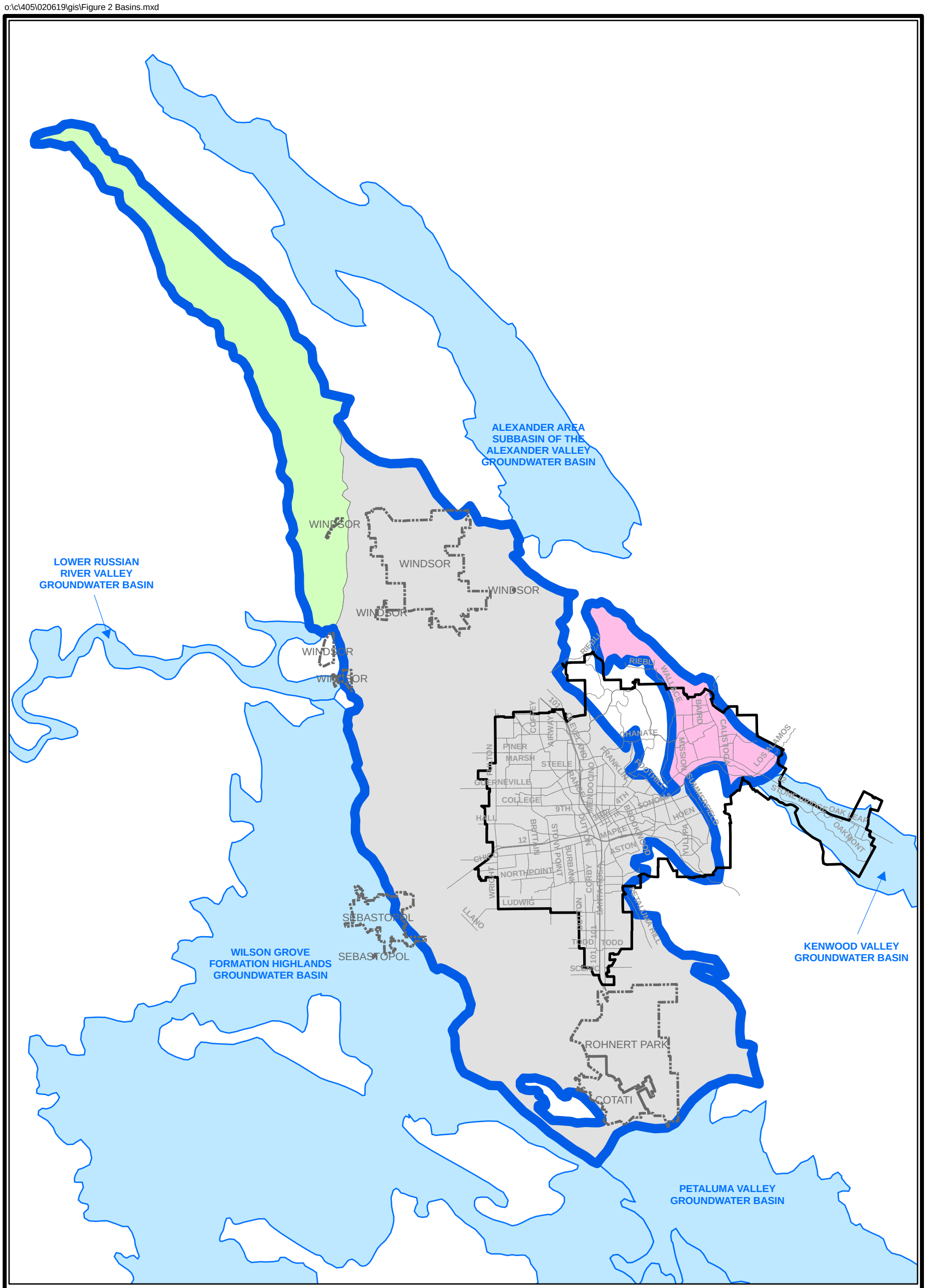
Groundwater Basin Name	Sub-basin Name	DWR Basin Number	Surface Area
Santa Rosa Valley Groundwater Basin[(b)]	Santa Rosa Plain Sub-basin	1-55.01	80,000 acres (125 square miles)
	Rincon Valley Sub-basin	1-55.03	5,600 acres (9 square miles)
Kenwood Valley Groundwater Basin	None	2-19	5,120 acres (8 square miles)

(a) Source: Department of Water Resources Bulletin 118, Groundwater Basin Descriptions, updated February 27, 2004.

(b) As shown on Figure 1, the Santa Rosa Valley Groundwater Basin also has a third sub-basin named the Healdsburg Area Sub-basin, located north of the City of Santa Rosa. However, because the City of Santa Rosa does not overlie any portion of the Healdsburg Area Sub-basin, it is not included here.

Although the City UGB overlies portions of the Rincon Valley Sub-basin and the Kenwood Valley Groundwater Basin, the City's groundwater supply is derived exclusively from the Santa Rosa Plain Sub-basin of the Santa Rosa Valley Groundwater Basin. The City does not derive any groundwater supply from the Rincon Valley Sub-basin or the Kenwood Valley Groundwater Basin. Hence, the focus of the following discussion will be on the Santa Rosa Plain Sub-basin. However, for completeness, brief descriptions of the Rincon Valley Sub-basin and the Kenwood Valley Groundwater Basin are also provided.

o:\c\405\020619\gis\Figure 2 Basins.mxd



LEGEND:

- City of Santa Rosa Urban Boundary
- City Limits
- Major Roads
- Santa Rosa Valley Basin
- Healdsburg Area Sub-basin
- Rincon Valley Sub-basin
- Santa Rosa Plain Sub-basin
- Other Groundwater Basins

N

0 1 2 4

Scale in Miles

FIGURE 2

City of Santa Rosa
Water Supply Assessment for
Santa Rosa General Plan 2035
LOCATION OF MAJOR GROUNDWATER SUBBASINS

WEST YOST ASSOCIATES
Consulting Engineers

The following groundwater basin descriptions were derived from the California Department of Water Resources (DWR) Bulletin 118 (last updated in February 2004)[9], with additional information obtained from:

- Evaluation of Groundwater Resources in Sonoma County Volume 2: Santa Rosa Plain (DWR, 1982)
- Geologic Map of the Santa Rosa Quadrangle (CGS, 1999)

Santa Rosa Valley Groundwater Basin: The Santa Rosa Valley Groundwater Basin is one of the largest groundwater basins in DWR's North Coast Hydrologic Region and occupies a northwest-trending structural depression in the southern part of the Coast Ranges of Northern California in Sonoma County. This depression divides the Mendocino Range on the west from the Mayacamas and Sonoma Mountains on the east. The Santa Rosa Valley Groundwater Basin has three sub-basins: the Healdsburg Sub-basin, the Santa Rosa Plain Sub-basin, and the Rincon Valley Sub-basin. As shown on Figure 2, the City overlies a portion of the Santa Rosa Plain Sub-basin and the Rincon Valley Sub-basin.

Santa Rosa Plain and Rincon Valley Sub-basins: The Santa Rosa Plain Sub-basin (DWR Groundwater Basin Number 1-55.01) covers an area of 80,000 acres, or approximately 125 square miles. It is the largest sub-basin of the Santa Rosa Valley Groundwater Basin and is characterized by low relief with an average ground surface elevation of approximately 145 feet above mean sea level.

The Santa Rosa Plain Sub-basin is approximately 22 miles long and 0.2 miles wide at the northern end; approximately 9 miles wide through the Santa Rosa area; and about 6 miles wide at the south end of the plain near the City of Cotati. The Santa Rosa Plain Sub-basin is bounded on the northwest by the Russian River plain approximately one mile south of the City of Healdsburg and the Healdsburg Sub-basin. Mountains of the Mendocino Range flank the remaining western boundary. The southern end of the sub-basin is marked by a series of low hills, which form a drainage divide that separates the Santa Rosa Valley from the Petaluma Valley basin south of Cotati. The eastern sub-basin boundary is formed by the Sonoma Mountains south of Santa Rosa and the Mayacamas Mountains north of Santa Rosa.

The Santa Rosa Plain Sub-basin is drained principally by the Santa Rosa and Mark West Creeks that flow westward into the Laguna de Santa Rosa. The Laguna de Santa Rosa flows northward and discharges into the Russian River. Annual precipitation in the Santa Rosa Plain ranges from approximately 28 inches in the south to about 40 inches in the north.

The Rincon Valley Groundwater Sub-basin (DWR Groundwater Basin 1-55.03) occupies a small north to northwesterly trending structural trough located adjacent to the east side of the Santa Rosa Groundwater Sub-basin. Rincon Valley is approximately seven miles long, and has a width that varies from 0.5 to 2.5 miles. Rincon Valley encompasses an area of 5,600 acres, (approximately nine square miles) and is bounded by the Sonoma and Mayacamas Mountains, except to the southeast, where it is bounded by the Kenwood Valley Groundwater Basin, and on the southwest, where it

[9] California Department of Water Resources, Bulletin 118 California's Groundwater, Individual Groundwater Basin Description for Santa Rosa Valley, Santa Rosa Plain Sub-basin, last update February 27, 2004.

is bounded by the Santa Rosa Plain Groundwater Sub-basin. Rincon Valley is drained by Brush Creek, a tributary of Santa Rosa Creek.

Neither sub-basin is adjudicated. Neither sub-basin has been identified as an overdrafted basin, nor is anticipated to become an overdrafted basin according to DWR Bulletin 118.

2.4.4.1.2 Hydrogeologic Units

The following hydrogeologic descriptions were developed from information contained in the following references:

- Evaluation of Ground Water Resources Sonoma County, Volume 2: Santa Rosa Plain (DWR Bulletin 118-4) (September 1982)
- Geology and Groundwater in the Santa Rosa and Petaluma Valley Areas, Sonoma County, (USGS Water Supply Paper 1427), G.T. Cardwell (1958)
- Geology and Groundwater in Napa and Sonoma Valleys, Napa and Sonoma Counties, (USGS Water Supply Paper 1495), F. Kunkel and J.E. Upson (1960)

The major geologic formations comprising the Santa Rosa Plain and Rincon Valley Groundwater Sub-basins are, from youngest to oldest, Younger Alluvium, Older Alluvium (alluvial fan deposits), the undifferentiated Glen Ellen, Huichica Formations and related continental deposits, the Sonoma Volcanics, the Wilson Grove (formerly Merced) Formation and the Petaluma Formation. The Tolay Volcanics may also be present in the subsurface. The groundwater sub-basins are floored by low permeability rocks of the Franciscan Formation. A description of each of these units and their hydrogeologic properties is provided in Table 3.

Deposition of the Sonoma Volcanics, Wilson Grove Formation and Petaluma Formation began in the late Miocene, but the formations are mostly Pliocene age (1.8 to 5 million years). Deposition of the Wilson Grove and Petaluma Formations began somewhat earlier than the Sonoma Volcanics but otherwise the formations were formed over similar time frames in separate geographic areas. Most of the Wilson Grove Formation was formed in a shallow marine environment, while most of the Petaluma Formation and all of the Sonoma Volcanics were formed on land. Interbedding probably exists at the original depositional contact between the Wilson Grove Formation and Petaluma Formations, and between the Petaluma Formation and Sonoma Volcanics. Subsequent faulting has probably significantly affected the lateral and, to a somewhat lesser extent, vertical contact relationships between the formations.

The undifferentiated Huichica/Glen Ellen Formations and related continental deposits are late Pliocene to Pleistocene in age and were deposited after the Wilson Grove and Petaluma Formations. The lower part of the undifferentiated Huichica/Glen Ellen Formations and related, undifferentiated continental deposits may have been deposited concurrent with the upper Sonoma Volcanics.

Table 3 – Summary of Geological Units in the Santa Rosa and Rincon Valley Groundwater Sub-basins[a]

Geological Unit	Map[b] Symbol	Lithology	Specific Yield	Comments
Younger Alluvium	Q	Interbedded layers of sand, silt, clay, and gravel	Variable (3-15%)	May contain objectionable levels of iron and manganese above secondary drinking water standards.
Older Alluvium (Alluvial Fan Deposits)	Qo	Fine sand, silt, and silty clay, coarse sand and gravel, with gravel more abundant near fan heads	Moderate to high (8-17%)	Lenses of very fine sand. Minor amounts of methane gas. May contain objectionable levels of iron and manganese above secondary drinking water standards.
Glen Ellen and Huichica Formations and related, undiffentiated continental deposits	QT	Cemented gravel, sand, silt and clay, local interbedded tuff	Low (3-7%)	Generally low yields unless a substantial thickness of coarse gravel and sand is penetrated. May contain objectionable levels of iron and manganese above secondary drinking water standards.
Sonoma Volcanics	Psv	Volcanic flows, agglomerates, and tuffs	Highly Variable (0-15%)	Variable yields. Some water has high boron content. Some waters thermal. Zones of hydrogen sulfide (H_2S). May occasionally exceed secondary drinking water standards for iron and manganese.
Wilson Grove (formerly Merced) Formation	Pwg	Mostly marine coarse-to-fine grained sandstone with minor amounts of clay. Sandstone is typically yellow, gray, or buff-white in surface exposures and distinctively blue in subsurface cuttings.	High (10-20%)	Lenses of very fine sand. Drillers' well logs generally describe this unit as blue sand, blue sandstone, cemented sand, or blue rock with some intervals of blue clay. Zones of high concentration of methane gas. May occasionally exceed secondary drinking water standards for iron and manganese. Water not as hard as other formations.
Petaluma Formation	Pp	Mostly non-marine clay and shale with minor amounts of sandstone	Low (3-7%)	Generally low yields. Yields may be higher for wells penetrating lenses of coarse material. Wilson Grove and Petaluma formations deposited at about the same time – driller's logs indicate alternating layers of blue sandstone and blue clay. Zones of hydrogen sulfide (H_2S). May contain objectionable levels of iron and manganese.
Tolay Volcanics	Ttv	Volcanic flows, tuffs, breccias and agglomerates	Unknown	Variable yields. Fair to good water producer regionally.
Franciscan Complex	KJf	Mélange, including chert, sandstone, shale, greenstone, and serpentinite.	Very low (<3%)	Low yields. Poor quality water in thermal and serpentinite areas. Good quality locally.

(a) Based on Table I in DWR Bulletin 118-4, Evaluation of Ground Water Resources Sonoma County, Volume 2: Santa Rosa Plain (September 1982)

(b) Geologic Map of the Santa Rosa Quadrangle; 1:250,000, California Geological Survey, 1999

The hydrogeologic properties of each unit are summarized below:

- Younger and Older Alluvium: Alluvial deposits blanket portions of the Santa Rosa Plain and Rincon Valley. The deposits consist of poorly sorted coarse sand and gravel, and moderately sorted fine sand, silt, and clay, and have specific yields of 3 to 17 percent. The older alluvial deposits are Late Pleistocene in age, are sometimes dissected, and have a maximum exposed thickness of 100 feet. The younger alluvium is a thin veneer over the Older Alluvium, ranging from 30 to 100 feet thick, and is Late Pleistocene to Holocene in age. The deposits are not perennially saturated, have low permeability, and are generally unconfined or slightly confined.
- Undifferentiated Glen Ellen and Huichica Formations and Related Continental Deposits: These late Pliocene to Pleistocene continental deposits crop out extensively in the central Santa Rosa Plain and in the northern and eastern Rincon Valley area. The deposits consist of partially cemented beds and lenses of poorly sorted gravel, sand, silt, and clay that vary widely in thickness and extent. It is reported that some wells sourced from the Glen Ellen produce more than 500 gallons per minute (gpm), but for most wells the specific capacities are less than 10 gpm per foot. Average specific yield for the Glen Ellen Formation is 3 to 7 percent.
- Sonoma Volcanics: The Pliocene Sonoma Volcanics consists of a thick and heterogeneous sequence of basalt, andesite and rhyolite flows interbedded with locally welded, pumiceous ash flow tuff and volcanic sedimentary deposits, including tuffaceous sands and volcanic gravels (DWR, 1982). Because of their heterogeneous nature, the Sonoma Volcanics have a highly variable specific yield. The volcanic flow rocks are essentially non-water bearing except where fractured by fault activity (DWR, 1982). Where fractured the volcanic flow rocks can produce substantial quantities of water. Specific yields range from 0 to 15 percent.
- Wilson Grove (Formerly Merced) Formation: The Wilson Grove (formerly Merced) Formation is a major water-bearing unit west of the City. It forms the hills to the west of the City. The surface exposure of the Wilson Grove Formation is limited on the east at Laguna de Santa Rosa, slightly east of Highway 116. The formation is Miocene to Pliocene and its thickness is estimated to range from 300 to greater than 1,500 feet. The Wilson Grove Formation is a marine deposit of fine sand and sandstone, but has thin interbeds of clay and silty-clay, some lenses of gravel, and localized fossils. Aquifer continuity and water quality are generally very good, with well yields from 100 to 1,500 gpm and specific yields from 10 to 20 percent.
- Petaluma Formation: The mid-to-late Pliocene Petaluma Formation underlies much of the Santa Rosa Plain and Rincon Valley Groundwater Sub-basins. The Petaluma Formation consists of continental and shallow marine to brackish water deposits of clay, shale, and sandstone with lesser amounts of conglomerate and nodular limestone and occasional thick beds of diatomite (DWR, 1982). The formation is characterized by abundant clay. Hydrogen sulfide has been found in wells penetrating the Petaluma Formation in the Santa Rosa Plain (DWR, 1982).

- The Petaluma Formation is capable of yielding moderate amounts of water to wells provided that appreciable thicknesses of sand and gravel are penetrated by the screened section of the wells. The unit has a low overall specific yield, ranging from 3 to 7 percent because of the large percentage of fine-grained material.
- Tolay Volcanics: The Miocene to early Pliocene Tolay Volcanics may be present in the subsurface beneath the Santa Rosa Plain and Rincon Valley Groundwater Sub-basins. The Tolay Volcanics were originally mapped as Sonoma Volcanics, but radiometric age dating has shown that extrusion of the Tolay Volcanics occurred before deposition of the Petaluma and Wilson Grove Formations and extrusion of the Sonoma Volcanics (DWR, 1982). The Tolay Volcanics consists of lava flows, breccias, tuffs and agglomerates with interbedded stream channel deposits (DWR, 1982). According to DWR (DWR, 1982), the Tolay Volcanics have a highly variable specific yield, and are considered have fair to good water yield in some areas. The lava flows are essentially non-water bearing except where highly fractured by faulting (DWR, 1982). Specific yields are unknown in the Santa Rosa Plain and Rincon Valley Groundwater Sub-basins.
- Franciscan Complex: Jurassic and Cretaceous rocks of the Franciscan Complex are the oldest rocks in the vicinity of the City. These rocks underlie the adjacent ranges and are probably present at depth beneath the Santa Rosa Plain and Rincon Valley. The Jurassic and Cretaceous age rocks are composed mostly of metasedimentary and other metamorphic rocks that locally yield small quantities of water from fractures and permeable lenses (Kunkel and Upson, 1960). Specific yields are less than 3 percent.

Kenwood Valley Groundwater Basin: The Kenwood Valley Groundwater Basin (DWR Basin Number 2-19) is located east of the Santa Rosa Valley and the City of Santa Rosa in Sonoma County and covers an area of approximately 5,120 acres, or approximately 8 square miles. Kenwood Valley occupies a portion of a small north to northwest-trending structural trough located to the southeast of the Rincon Valley Sub-basin. It is not an adjudicated groundwater basin. It has not been identified as an overdrafted basin and is not anticipated to become an overdrafted basin.

The Kenwood Valley Groundwater Basin is approximately 4 miles long along its eastern edge and varies in width from about 0.5 miles to 2 miles. The majority of the Kenwood Valley Groundwater Basin is bounded by the Napa-Sonoma Volcanic Highlands, except for the northwest side, where the Kenwood Valley is separated from the Rincon Valley Sub-basin by Santa Rosa Creek.

The Kenwood Valley Groundwater Basin is drained by the Santa Rosa and Sonoma Creeks. The principal water-bearing units in this groundwater basin are Alluvium and the Glen Ellen Formation (see descriptions above). This basin is tapped for domestic used by the Kenwood Village Water Company for residents in the Kenwood area.

2.4.4.1.3 Groundwater Level Trends

The evaluation of historical groundwater levels in this WSA provides a hydrologic assessment of the condition of the Santa Rosa Plain Sub-basin. Many of the wells evaluated for this WSA have groundwater level data available on either a semi-annual or monthly basis. However, in order to screen out normal seasonal groundwater level fluctuations, only the year-to-year springtime groundwater level measurements have been evaluated. These springtime groundwater level measurements are an indication of the basin's ability to "recover" on an annual basis following typical higher groundwater pumpage during the summer months and natural groundwater recharge during the rainy season. If springtime groundwater levels are stable from year to year, this indicates that annual groundwater pumpage is approximately equal to annual groundwater recharge. If springtime groundwater levels are increasing, this indicates that annual groundwater pumpage is less than annual groundwater recharge. Overall, stable or increasing springtime groundwater levels indicate that groundwater extraction is not exceeding recharge, and that the basin is in good condition and is not in overdraft. If springtime groundwater levels are decreasing, this indicates that annual groundwater recharge is less than annual groundwater pumpage. As defined above, long term pumping which exceeds the amount of water that recharges the basin may result in overdraft.

Santa Rosa Plain Sub-basin: The DWR Bulletin 118 updated in February 2004 states that the Santa Rosa Plain Sub-basin "as a whole is about in balance, with increased groundwater levels in the northeast contrasting with decreased groundwater levels in the south." Review of spring groundwater levels in wells actively monitored by DWR generally supports these findings, in that a majority of the wells actively monitored by DWR located throughout the sub-basin have demonstrated either increasing or stable groundwater levels, indicating that the sub-basin is in balance and is not being overdrafted. An overdrafted groundwater basin would generally be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. This is not the case for the Santa Rosa Plain Sub-basin. Also, all of the actively monitored wells in and around the vicinity of the City have demonstrated either stable or increasing spring groundwater levels. Further discussion regarding groundwater levels in this sub-basin follows.

DWR has historically monitored groundwater levels in 75 wells located within the Santa Rosa Plain Sub-basin and Rincon Valley Sub-basin. This data is available on DWR's on-line Water Data Library[10]. Of these 75 wells, 28 wells are currently actively monitored by DWR on either a semi-annual or monthly basis. Most of these wells have been monitored since 1989, while many have data extending back to the 1970's. One well, Well 06N/08W-15J3, located south of the City near Rohnert Park, has been monitored since 1950.

Figure 3 shows the locations of the DWR-monitored wells, as well as the locations of the City's wells, the Agency's wells and the approximate location and number of other municipal wells located within the Santa Rosa Plain Sub-basin. For the wells that are actively monitored by DWR, groundwater level trends are indicated on Figure 3 by color code. Wells shown in green have demonstrated increasing groundwater levels, wells shown in yellow have demonstrated stable groundwater

[10] DWR Water Data Library http://wdl.water.ca.gov

o:\c\405\020619\gis\Figure 3.mxd

NOTES:

- Groundwater level trend in DWR monitored wells are shown for actively monitored wells and include data through 2007/2008 (where available).

- Private wells are not shown.

ALEXANDER AREA SUBBASIN OF THE ALEXANDER VALLEY GROUNDWATER BASIN

LOWER RUSSIAN RIVER VALLEY GROUNDWATER BASIN

RUSSIAN RIVER

WILSON GROVE FORMATION HIGHLANDS GROUNDWATER BASIN

KENWOOD VALLEY GROUNDWATER BASIN

PETALUMA VALLEY GROUNDWATER BASIN

Town of Windsor
(5 Active Municipal Wells & 3 Emergency Wells)

California American Water
(4 Active Municipal Wells)

City of Santa Rosa
(2 Active Municipal Wells, 3 Standby Municipal Wells & 1 Irrigation Well)

City of Sebastopol
(4 Active Municipal Wells with Stable Water Levels)

City of Rohnert Park
(26 Active Municipal Wells with Increasing Water Levels)

City of Cotati
(3 Municipal Wells)

Riverbank
Keiser Park
08N09W-12P1
Bluebird
Esposti Park
08N08W-29C3
08N08W-29B1
Larkfield 4A
Larkfield 1A
Larkfield 5
Larkfield 3A
08N09W-36N1
07N09W-01C1
08N09W-36P1
Leete
07N07W-06H2
07N07W-09P1
07N09W-16M1
07N09W-15K1
Farmers Lane
Carley
Peter Springs
07N07W-19B1
07N07W-19F2
07N08W-21J1
SCWA 06
Occidental Road
07N09W-26P1
SCWA 05
Sebastopol Road
07N09W-34F1
07N08W-35K1
Well 08
Well 04
Well 06
Well 07
SCWA 04
Todd Road
06N08W-04Q1
06N08W-11P1
06N08W-12M1
06N08W-15A2
06N08W-15J3
SSU 3
SSU 2
SSU 1
Cotati 3
Penngrove WC
Cotati 1
Cotati 2
05N08W-02H1
05N08W-01L2

LEGEND:

- Decreasing GW Levels
- Stable GW Levels
- Increasing GW Levels
- Inactive DWR Monitored Wells
- Municipal Well (WL Data NA)
- Russian River
- City of Santa Rosa Urban Boundary
- City Limits
- Santa Rosa Valley Basin
- Healdsburg Area Sub-basin
- Rincon Valley Sub-basin
- Santa Rosa Plain Sub-basin
- Other Groundwater Basins

N

0 1 2 4

Scale in Miles

FIGURE 3

City of Santa Rosa
Water Supply Assessment for Santa Rosa General Plan 2035
REGIONAL GROUNDWATER LEVEL SUMMARY

WEST YOST ASSOCIATES
Consulting Engineers

levels, and wells shown in red have demonstrated declining water levels. As shown, most of the currently monitored wells located throughout the sub-basin have demonstrated either increasing or stable groundwater levels, indicating that the sub-basin is in balance and is not being overdrafted.

Only two of the actively monitored wells within the Santa Rosa Plain Sub-basin have had decreasing groundwater levels. As explained further below, these decreases are considered to be localized and are not considered to be indicative of overall sub-basin conditions. As shown on Figure 2, these two wells are located on the western fringe of the sub-basin: Well 07N/09W-26P1 and Well 06N/08W-07P2. Well 07N/09W-26P1 is showing an overall gradual groundwater level decrease of about 12 feet since about 2000 (averaging about 1.5 feet per year). Water levels in Well 06N/08W-07P2 have decreased by about 10 feet from 1989 to 2006; no data was available for 2007 and 2008. However, because both of these wells are located on the fringe of the sub-basin, these groundwater level declines are likely the result of localized conditions and are not considered to be indicative of groundwater conditions within the overall sub-basin. Two other wells located in the Rohnert Park area, Well 06N/07W-30C1 and Well 06N/08W-15J3, have experienced decreasing groundwater levels in the past. However, since about 2002, groundwater levels in these two wells have increased significantly, possibly as a result of reduced municipal pumpage in the area by the City of Rohnert Park. It should be noted that some of the actively monitored wells show a slight decrease in water levels in 2007 and 2008. This is likely due to the dry hydrologic conditions that occurred in those years, and corresponding increase in groundwater pumpage by the domestic/rural water users, and municipal users due to a reduction in available supply from SCWA. These recent groundwater level decreases are considered to be indicative of the normal conjunctive use of the groundwater basin, and are representative of the dry year conditions which occurred in 2007 and 2008, and the natural hydrologic cycles that occur over time, and are not considered to be a concern. Hydrographs for the 28 wells actively monitored by DWR are included in Appendix A.

Historical groundwater level data were also reviewed for the remaining DWR-monitored wells which are no longer monitored. Most of those wells also demonstrated either increasing or stable groundwater levels over their respective periods of record, while some had inconclusive data due to brief periods of record or sporadic data. Five other DWR-monitored wells, one located north of the City in the Windsor area, one located just north of the City, two located in the southern part of the City, and one located southwest of the City on the western fringe of the Santa Rosa Plain Sub-basin, demonstrated declining water level trends. As discussed above, the historical groundwater level declines in these wells are considered to be the result of localized groundwater pumpage and are not considered to be indicative of groundwater conditions in the overall sub-basin.

Groundwater level data for the City's municipal wells was also reviewed. For the City's Carley Well, Peters Spring Well, and Farmers Lane Wells No. 1, 2 and 3, historical groundwater levels from the 1940's and 1950's were compared to current groundwater levels. Although the available data is limited, the data indicate for each of these wells that groundwater levels have increased significantly from 14 to 94 feet below groundwater surface in the 1940's and 1950's to essentially artesian conditions (e.g., groundwater level at or above ground surface). Currently, all of the City's municipal wells (except the Carley and Peters Spring Wells) are demonstrating artesian conditions, indicating an abundance of groundwater in the portion of the sub-basin

underlying the City (the Carley and Peters Spring wells currently have water levels within a few feet of the ground surface). Hydrographs for the City's municipal wells are included in Appendix B. It is also interesting to note that groundwater level data collected from the Farmers Lane Wells after the 2007 summer pumpage period indicated that water levels quickly recovered to artesian conditions after the wells were turned off.

Rincon Valley Sub-basin: Review of water level data from representative wells within Rincon Valley indicates that water levels have remained relatively stable during the period from 1951 to 2000 and that the sub-basin is nearly full.[11] One well located in the southeast part of the sub-basin near Santa Rosa Creek has shown a gradual increase in water level of over 20 feet between 1990 and 2000.[12] Two of the DWR-monitored wells discussed above for the Santa Rosa Plain Sub-basin actually appear to be located within the Rincon Valley Sub-basin (see Figure 3). Well 07N/07W-09P1 has demonstrated increased groundwater levels since 1989 and Well 07N/07W-06H2 has demonstrated stable groundwater levels since 1989.

Kenwood Valley Groundwater Basin: DWR monitors five wells in the Kenwood area, ranging in depth from 76 to 406 feet. According to a 2006 United States Geological Survey (USGS) report of groundwater in the Sonoma Valley area (USGS 2006), data for four of these wells show no significant water level trends over the period of record (the last 15 to 20 years). Data for one well show a trend of declining water levels and increasing annual fluctuation, indicative of increased groundwater extraction near the well.

City of Santa Rosa Region: Review of hydrographs near the City's Farmers Lane wells shows that groundwater elevations have been high (within 10 to 30 feet of the ground surface) and stable since at least 1989, indicating that groundwater recharge is taking place and that additional groundwater yield from this area is possible. The hydrographs also indicate that groundwater elevations to the east of the Farmers Lane wells are significantly higher than the ground surface at the Farmers Lane wells, which provides additional explanation for the artesian conditions at the Farmers Lane wells.[13]

2.4.4.1.4 Groundwater Storage

Santa Rosa Plain Sub-basin: Over the years, several estimates have been made of the groundwater storage capacity of the Santa Rosa Plain Sub-basin. These estimates range from 948,000 af to 4,313,000 af. A brief description of each estimate follows:

- The USGS estimated the gross groundwater storage capacity for this basin to be about 948,000 af based on the average specific yield of 7.8 percent for aquifer materials at depths of 10 to 200 feet[14].

[11] Evaluation of Ground Water Resources: Sonoma County. Volume 1: Geologic and Hydrologic Data. DWR Bulletin 118-4, 1975 and DWR unpublished data as documented in DWR Bulletin 118, 2003.

[12] DWR Unpublished Data as documented in DWR Bulletin 118, 2003.

[13] Technical Memorandum, Evaluation of Potential Impacts Associated with Increased Groundwater Production from Farmers Lane Wells W4-1 and W4-2, prepared by West Yost & Associates, July 22, 2004.

[14] Cardwell, G.T., Geology and Ground Water in the Santa Rosa and Petaluma Valley Areas, Sonoma County, California, USGS

- The DWR performed a study of the area in 1982 and calculated the groundwater storage capacity for this basin to be 4,313,000 af. This calculation was made using the TRANSCAP computer program, assuming aquifer thicknesses ranged from 50 to over 1,000 feet with an average thickness of approximately 400 feet.[15]

Using the water level information for the spring of 1980 and the product of the TRANSCAP computer program, the volume of groundwater in storage was estimated to be 3,910,000 af.

Rincon Valley Sub-basin: Over the years, several estimates have been made for the groundwater storage capacity of the Rincon Valley Sub-basin. These estimates range from 21,000 af to 290,000 af. A brief description of each estimate follows:
An estimate of the gross groundwater storage capacity for the Rincon Valley of 21,000 af was developed by the USGS using an average specific yield of 5.5 percent for an estimated 190 feet of primary water-bearing materials.[16]

An estimate of the total groundwater storage capacity of 45,000 af was calculated for a large portion of the Rincon Valley Sub-basin and a smaller portion of the Kenwood Valley Groundwater Basin. This estimate was based on the alluvium from a depth of 10 to 200 feet and an average specific yield of 5.5 percent. The depth range used for this estimate probably includes a portion of the Glen Ellen Formation.[17]

Bulletin 118-4 provided an estimate of the gross storage capacity for the Rincon Valley Sub-basin of 290,000 af. This estimate was obtained using the GEOLOG program and an average specific yield of 6.83 percent; however, this value cannot be construed to be the usable groundwater storage capacity.[18]

An estimate of the groundwater in storage during the spring of 1980 of approximately 43,000 af was obtained using data from Bulletin 118-4.[19] However, this estimate was obtained for an area less than that of the currently defined Rincon Valley Sub-basin.

Kenwood Valley Groundwater Basin: According to DWR's September 1975 edition of Bulletin 118, the total groundwater storage capacity of the Kenwood Valley Groundwater Basin was estimated to be 460,000 af, with a usable capacity of 27,000 af.[20]

No estimates of groundwater storage in the Kenwood Valley Groundwater Basin were made during the 2006 USGS study because the complexity of subsurface stratigraphy and lithologic characteristics would lead to very large uncertainties in any estimate.

Water Supply Paper 1427, 1958.

15 California Department of Water Resources, Evaluation of Ground Water Resources in Sonoma County Volume 2: Santa Rosa Plain, DWR Bulletin 118-4, 1982.

16 Cardwell, G.T., Geology and Ground Water in the Santa Rosa and Petaluma Valley Areas, Sonoma County, California, USGS Water Supply Paper 1427, 1958.

17 California Department of Water Resources, Water Resources and Future Water Requirements, North Coast Hydrographic Region, Volume 1: Southern Region, DWR Bulletin 142-1, 1965.

18 California Department of Water Resources, Evaluation of Ground Water Resources in Sonoma County Volume 2: Santa Rosa Plain, DWR Bulletin 118-4, 1982.

19 California Department of Water Resources, Evaluation of Ground Water Resources in Sonoma County Volume 2: Santa Rosa Plain, DWR Bulletin 118-4, 1982.

20 California Department of Water Resources, DWR Bulletin 118, September 1975.

2.4.4.1.5 Groundwater Budget

Santa Rosa Plain Sub-basin: According to the DWR Bulletin 118, a groundwater model for the Santa Rosa Plain Sub-basin was prepared by the DWR in 1982. The 15-year period from 1960-61 through 1974-75 was selected as the study period for the Santa Rosa Plain Sub-basin because it contained a mixture of wet and dry years approximating long-term climatic conditions. Average annual natural recharge for the period 1960 to 1975 was estimated to be about 29,300 af. Average annual pumping during the same time period was estimated to be approximately 29,700 af, indicating that the annual natural recharge and the annual pumping within the sub-basin were essentially in balance.

Rincon Valley Sub-basin: According to DWR Bulletin 118, there is not enough data available to estimate a groundwater budget for the Rincon Valley Sub-basin.

Kenwood Valley Groundwater Basin: No data was available for groundwater budget within the Kenwood Valley Groundwater Basin.

City of Santa Rosa Region: With respect to the area in the vicinity of the City's Farmers Lane wells, it has been estimated that the annual groundwater recharge to the area from which the Farmers Lane wells extract groundwater is on the order of 2,500 afy, using historical rainfall data and an estimate of the potential recharge area[21]. This quantity of recharge is larger than the maximum quantity of groundwater the City plans to pump from the Farmers Lane wells (2,300 afy).

2.4.4.1.6 Groundwater Quality

Santa Rosa Plain Sub-basin: On the western side of the basin, sodium and bicarbonate are the dominant cation and anion components in water from all depths. Moving south along the western boundary, the shallow waters have magnesium and calcium as the dominant cation and in the deep zone (below 150 feet) sodium dominates. In the vicinity of Windsor, magnesium chloride water is present in the shallow aquifer to a depth of about 100 feet. In the Santa Rosa area, groundwater at all depths is characterized primarily by sodium and magnesium bicarbonate types. In the Rohnert Park vicinity, groundwater in the deep zone (below 150 feet) is characterized by sodium and calcium bicarbonate type water.[22]

According to a DWR study of the basin, few wells tested for water quality contained constituents over the recommended concentration for drinking water. Many wells produced water with aesthetic problems such as elevated concentrations of iron, manganese, or high hardness. Private well owners questioned about groundwater quality reported many complaints about the color and/or taste of the water. Although high iron, manganese, and hardness have been reported in groundwater for some

[21] Technical Memorandum, Evaluation of Potential Impacts Associated with Increased Groundwater Production from Farmers Lane Wells W4-1 and W4-2, prepared by West Yost & Associates, July 22, 2004.

[22] California Department of Water Resources, Evaluation of Ground Water Resources in Sonoma County Volume 2: Santa Rosa Plain, DWR Bulletin 118-4, 1982.

portions of the Santa Rosa Plain Sub-basin, the overall quality of groundwater in the Santa Rosa Plain Sub-basin is good.[23]

Rincon Valley Sub-basin: The Rincon Valley Sub-basin is generally characterized by a calcium-bicarbonate water type. A localized area of sodium and/or magnesium chloride water is present in the southwest portion of the sub-basin. In the southern portions of the sub-basin, groundwater hardness ranges from about 100 to 200 mg/L. Also, in the southwest portion of the sub-basin near the boundary with the Santa Rosa Plain Sub-basin, an area of elevated iron, manganese, and boron was reported.[24]

Kenwood Valley Groundwater Basin: According to the 2006 USGS study, groundwater in wells less than 200 feet deep in the Kenwood area is generally characterized by a magnesium bicarbonate water type. Deeper wells in the Kenwood area, between 200 and 500 feet deep, produced groundwater which is characterized by a sodium and magnesium bicarbonate water type. According to fall 2002 sampling data presented in the 2006 USGS study, both nitrate and boron concentrations in wells in the Kenwood area were low.

City of Santa Rosa Region: The City's Farmers Lane wells have historically exhibited slightly elevated concentrations of both iron and manganese, exceeding secondary drinking water standards. A treatment system for iron and manganese removal has been constructed at the site of the City's Farmers Lane wells to treat groundwater pumped from Farmers Lane Wells No. 1 and 2 before entering the City's distribution system.

2.4.4.2 Existing Groundwater Supply

The City maintains a total of six municipal groundwater wells within the Santa Rosa Plain Sub-basin of the Santa Rosa Valley Groundwater Basin. They are described as follows:

- Farmers Lane Wells No. 1 and 2: These two wells were changed from emergency to active status by DPH (formerly referred to as the Department of Health Services, DHS) on July 20, 2005 and can be used to provide up to 2,300 afy. These are the only potable groundwater sources used by the City. They have been used recently to supplement potable water supplies obtained from SCWA, particularly during high demand, peak summer periods;
- Carley Well and Peters Spring Well: These two wells are currently operated primarily to provide landscape irrigation to an adjacent park and school ground area, but these wells are also permitted by DPH to operate and provide potable supply during an emergency outage condition;
- Farmers Lane Well No. 3: This well is only operated to provide minor amounts of landscape irrigation water supply to areas adjacent to the well; and

[23] California Department of Water Resources, Bulletin 118 California's Groundwater, Individual Groundwater Basin Description for Santa Rosa Valley, Santa Rosa Plain Sub-basin, last update February 27, 2004.

[24] Evaluation of Ground Water Resources: Sonoma County. Volume 1: Geologic and Hydrologic Data. DWR Bulletin 118-4, 1975.

- Leete Well: This well is only used to provide potable water during an emergency outage condition (as permitted by DPH).

2.4.4.2.1 Overall Existing Groundwater Pumpage

Santa Rosa Plain Sub-basin: There are a number of public entities that pump groundwater from municipal wells located within the Santa Rosa Plain Sub-basin. These agencies include SCWA, the City of Santa Rosa, the Town of Windsor, the City of Sebastopol, the City of Rohnert Park, the City of Cotati, California American Water, Penngrove Water Company and Sonoma State University. Table 4 lists the number of municipal wells operated by each agency. The approximate locations of these municipal wells are shown on Figure 3.

Table 4 – Municipal Wells Located in the Santa Rosa Plain Sub-basin

Agency	Number of Wells
Sonoma County Water Agency	Three (3) municipal wells
City of Santa Rosa	Six (6) municipal wells • Two wells were changed from standby to active status in 2005 (Farmers Lane Nos. 1 and 2) • One well is operated to provide minor amounts of landscape irrigation water supply only (Farmers Lane No. 3) • Two wells are used for some minor amounts of landscape irrigation and available for emergency purposes (Carley Well and Peters Spring Well) • One well is operated for emergency purposes only and remains on standby (Leete Well)
Town of Windsor	Five (5) active municipal wells and three (3) emergency wells[(a)]
City of Sebastopol	Four (4) municipal wells[(b)]
City of Rohnert Park	Twenty-six (26) active municipal wells[(c)]
City of Cotati	Three (3) municipal wells[(d)]
California American Water	Four (4) municipal wells[(e)]
Penngrove Water Company	One (1) municipal well[(f)]
Sonoma State University	Three (3) municipal wells[(f)]

(a) Source: E-mail from Craig Scott (Senior Engineer, Town of Windsor) to Jennifer Burke (City of Santa Rosa), September 8, 2008.

(b) Source: City of Sebastopol Consumer Confidence Report for Calendar Year 2007, July 1, 2008; and e-mail from Sue Kelly to Jennifer Burke dated September 23, 2008.

(c) Source: City of Rohnert Park 2005 Urban Water Management Plan, prepared by Winzler & Kelly Consulting Engineers, adopted August 28, 2007.

(d) Source: City of Cotati 2006 Urban Water Management Plan, prepared by Winzler & Kelly Consulting Engineers, November 2006.

(e) Source: Operations Plan for Groundwater Supply Wells in the Larkfield District, prepared for California American Water, prepared by Bookman-Edmonston, October 14, 2004.

(f) Canon Manor West Subdivision Assessment District Groundwater Study, Figure 5, Todd Engineers, June 2004.

In addition to municipal pumpage, there are a number of private, commercial and agricultural wells located within the Santa Rosa Plain Sub-basin. The exact number and annual groundwater pumpage from these wells is unknown. The USGS, in partnership with SCWA, the cities of Santa Rosa, Rohnert Park, Cotati, and Sebastopol, the Town of Windsor, California American Water, and others, are looking to better quantify these values, as part of an on-going multi-year cooperative study.

Rincon Valley Sub-basin: There is no municipal groundwater pumpage within the Rincon Valley Sub-basin. Groundwater pumpage within this sub-basin is primarily by private users for domestic and some landscape irrigation use. The exact number and annual groundwater pumpage from these wells is unknown.

Kenwood Valley Groundwater Basin: There is no available data on municipal groundwater pumpage within the Kenwood Valley Groundwater Basin. Historically, groundwater pumpage within this basin has been primarily by private users for domestic use. The Kenwood Village Water Company pumps groundwater from the Kenwood Valley Groundwater Basin to serve residents in the Kenwood area. The exact number and annual groundwater pumpage from these wells is unknown.

2.4.4.2.2 SCWA Existing Groundwater Pumpage

SCWA pumps groundwater from the Santa Rosa Plain Sub-basin to supplement its Russian River water supply. However, because these wells feed into SCWA's Cotati Aqueduct transmission system, which provides no supply to the City, little or no SCWA groundwater is actually delivered to the City by SCWA to meet the City's 29,100 af of contractual supply entitlement. Nevertheless, available data on SCWA's historical groundwater pumping is being included in this WSA as supplemental information.

SCWA's three groundwater wells are located along SCWA's Cotati Aqueduct at Todd Road (SCWA-04), Sebastopol Road (SCWA-05), and Occidental Road (SCWA-06), on the west side of the Santa Rosa Plain Sub-basin. The locations of these wells are shown on Figure 2. All three wells are drilled to depths greater than 1,000 feet.[25] SCWA does not have any wells within the Rincon Valley Sub-basin or the Kenwood Valley Groundwater Basin. Table 5 summarizes SCWA's groundwater pumpage quantities in the last seven years, which up until 2006 represented an average of approximately 5.5 percent of the SCWA total annual transmission system delivery. However, in 2007, SCWA only pumped 1,634 afy, which only represented about 2.7 percent of the SCWA total annual transmission system delivery. It is the City's understanding that this decrease in 2007 SCWA pumpage was the result of one or more of these wells being out of service for a significant period of time.[26]

[25] City of Santa Rosa, Utilities Department Memorandum, Southwest Area Projects Water Supply Assessment Clarification, March 10, 2006.

[26] Communication with George Lincoln, Sonoma County Water Agency, September 2008.

Table 5 – Amount of Groundwater Pumped by the Sonoma County Water Agency in Past Seven Years

Basin/Sub-basin Name	Historical Groundwater Pumpage (afy)						
	2001	2002	2003	2004	2005	2006	2007
Santa Rosa Valley Groundwater Basin: Santa Rosa Plain Sub-basin	2,964[(a)]	3,592[(a)]	4,701[(a)]	4,585[(a)]	5,906[(b)]	3,710[(c)]	1,634[(c)]
Santa Rosa Valley Groundwater Basin: Rincon Valley Sub-basin	SCWA does not pump any groundwater from this groundwater sub-basin						
Kenwood Valley Groundwater Basin	SCWA does not pump any groundwater from this groundwater basin						

(a) Source: City of Santa Rosa Utilities Department Memorandum, Southwest Area Projects Water Supply Assessment Clarification, March 10, 2006.

(b) Source: Sonoma County Water Agency, 2005 Annual Water Quality Report-Amended, March 16, 2006.

(c) Source: Sonoma County Water Agency 2006 and 2007 Annual Water Quality Reports, respectively.

2.4.4.2.3 Existing Pumpage by Other Municipalities Within the Santa Rosa Plain Sub-Basin

City of Sebastopol: The City of Sebastopol currently has three (3) active municipal wells: Well #4, Well #6, and Well #7. A fourth well (Well #8) was placed in service in March 2008.

As shown in Table 6, total groundwater pumpage by the City of Sebastopol over the last five years has ranged from 1,204 afy in 2007 to 1,535 afy in 2004, averaging about 1,390 afy. Production in 2006 and 2007 was lower than in previous years due to decreased water usage.

Table 6 – City of Sebastopol Groundwater Pumpage Over Last Seven Years [(a)]

Calendar Year	2001	2002	2003	2004	2005	2006	2007
Municipal Groundwater Production, afy	1,519	1,526	1,415	1,535	1,307	1,211	1,204

(a) Source: Letter and attached data from Sue Kelly (City of Sebastopol) to Jennifer Burke (City of Santa Rosa) dated October 12, 2006 and E-mail from Sue Kelly to Jennifer Burke dated September 23, 2008 with 2006 and 2007 data.

Springtime groundwater levels in the City of Sebastopol's wells have varied from year to year, but have been relatively stable since 1990. Plots of historical groundwater pumpage and groundwater levels by well are provided in Appendix C.

City of Rohnert Park: The City of Rohnert Park has developed forty-two (42) groundwater wells, twenty-six (26) of which are currently active[27].

As shown in Table 7, groundwater pumpage by the City of Rohnert Park has significantly decreased in recent years from 4,482 afy in 2001 to 349 afy in 2006. The

[27] Page 4-3 City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

current groundwater pumpage of 934 afy in 2007 is considerably less than the City of Rohnert Park's historical groundwater pumpage which averaged 3,900 afy from 1980 to 1981, and 5,100 afy from 1990 to 1997[28]. In 2003, the City of Rohnert Park began to reduce its use of groundwater as a source of supply to meet its water demands due to implementation of its General Plan commitments to secure a greater percentage of its potable supply from SCWA.

Table 7 – City of Rohnert Park Groundwater Pumpage Over Last Seven Years [(a)]

Calendar Year	2001	2002	2003	2004	2005	2006	2007
Municipal Groundwater Production, afy	4,482	4,212	3,556	1,520	846	349	934

(a) Source: 2001 to 2005 data: Table 4-4, City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007. 2006 and 2007 data: August 20, 2008 e-mail from Darrin Jenkins (City of Rohnert Park) to Jennifer Burke (City of Santa Rosa).

Historical water levels in the City of Rohnert Park wells are provided in Appendix D. Water levels in the City of Rohnert Park wells generally follow the trend of the City's pumping, with lower water levels during years of increased pumping and higher water levels during years of reduced pumping. This means that water levels were lowest in the late 1980s, stabilized in the 1990s, and have increased significantly in recent years. Notably, groundwater levels have increased to elevations significantly above those observed in the early 1980's. Where historical records are available, current groundwater levels also appear to be higher than those recorded in the 1970's. For example, the groundwater elevations observed in January 1972 and March 1980 in City of Rohnert Park Well No. 8 were 89 and 79 feet, mean sea level (msl), respectively, whereas in March 2006, the groundwater elevation was 105 feet, msl.

Town of Windsor: The Town of Windsor (Town) currently has five (5) active wells and three (3) emergency wells. The five active wells are part of the Town's Russian River Well Field, from which production is governed by the Town's agreement with SCWA. Pumpage from these wells is based on SCWA's water rights, is considered to be part of the Town's SCWA supply, and is accounted for in the Restructured Agreement. The Town also has three "off-river" groundwater wells which pump from the Santa Rosa Plan Sub-basin. The Bluebird Well is a 400-foot well constructed in 1972. It had been placed on standby in the mid-1980s when the Russian River Well Field was developed, but was subsequently used as an off-river supply source to improve system reliability. However, in 2006, the Bluebird well once more was taken off-line due to arsenic issues. The Town also owns the Esposti Well and Keiser Park wells which are primarily used for park irrigation, as well as serving as a backup or emergency source of potable water.

As shown in Table 8, groundwater pumpage by the Town of Windsor from the Santa Rosa Plan Sub-basin has been relatively low over the past seven years, with zero pumpage in 2006 or 2007 due to arsenic issues at the Bluebird Well.

[28] Page 3-29 City of Rohnert Park Final Water Supply Assessment, January 2004.

Table 8 – Town of Windsor Groundwater Pumpage Over Last Seven Years [(a)]

Calendar Year	2001	2002	2003	2004	2005	2006	2007
Municipal Groundwater Production, afy	283	150	52	14	200	0	0

[(a)] Source: Table 4-1 Town of Windsor 2005 Urban Water Management Plan, adopted June 20, 2007. Includes only pumpage from the off-river Bluebird Well. The Bluebird Well was taken off-line in 2006 due to arsenic issues.

Available water level data for the Town of Windsor wells is extremely limited, and was not available for this analysis.

City of Cotati: The City of Cotati currently has three (3) active wells. Prior to 1992, the City of Cotati used groundwater to supply more than half of its demands. More recently, the City of Cotati's water strategy has been to primarily supply its demands through use of its SCWA water supply, and to use its local groundwater supplies to supplement its needs during peak periods and also during periods of drought.

As shown in Table 9, groundwater pumpage by the City of Cotati decreased from 532 afy in 2001 to only 49 afy in 2005. Pumpage in 2006 and 2007 increased slightly in response to dry hydrologic conditions and reduced supplies available from SCWA.

Table 9 – City of Cotati Groundwater Pumpage Over Last Seven Years [(a)]

Calendar Year	2001	2002	2003	2004	2005	2006	2007
Municipal Groundwater Production, afy	532	340	278	106	49	80	295

[(a)] Source: 2001-2005 data from Table 4-6 of City of Cotati 2006 Urban Water Management Plan, November 2006. 2006 and 2007 data from Water Source Usage Analysis July 2008.xls spreadsheet from City of Cotati.

Available water level data for the City of Cotati indicates increasing water levels in each of the City's wells in the last few years. Hydrographs for the City of Cotati wells are provided in Appendix E.

California American Water: The Larkfield District of California American Water currently has four groundwater wells. These wells, in addition to supplies from SCWA, are used to meet demands in the Larkfield District service area.

As shown in Table 10, groundwater pumpage by California American Water has decreased over the past five years, from almost 900 afy in 2003 to just about 680 afy in 2007.

Table 10 – California American Water Groundwater Pumpage Over Last Five Years [(a)]

Calendar Year	2003	2004	2005	2006	2007
Municipal Groundwater Production, afy	885	815	713	642	677

[(a)] Source: 2003-2007 well production data received from California American Water, September 2008.

Available water level data for California American Water indicates stable water levels in three of California American's wells in the last few years and increasing water levels in one well. Hydrographs for these wells are provided in Appendix F.

2.4.4.2.4 Existing City Municipal Groundwater Pumpage

The City has a total of six municipal groundwater wells within the Santa Rosa Plain Sub-basin. The locations of these wells are shown on Figure 3. These six wells are listed in Table 11 along with their current status.

As shown in Table 12, two of the City's municipal wells are currently operated primarily to provide some landscape irrigation to an adjacent park and school landscaping, but are also available and approved by DPH for emergency potable use, on a standby status (Carley and Peters Spring Wells), two of the wells (Farmers Lane Wells No. 1 and 2) are on active status (DPH on July 20, 2005), one well is operated to provide minor amounts of landscape irrigation water supply only (Farmers Lane Well No. 3), and one well is used for emergency potable purposes only (Leete Well).

Table 11 – City of Santa Rosa Municipal Groundwater Wells[(a)]

Well Name/Number	Well Status
Leete (W1)	Standby; used for emergency potable purposes only
Carley (W2-1)	Standby; used for emergency potable purposes and some landscape irrigation
Peters Spring (W2-2)	Standby; used for emergency potable purposes and some landscape irrigation
Farmers Lane (W4-1)	Active status[(b)]
Farmers Lane (W4-2)	Active status[(b)]
Farmers Lane (W4-3)	Not connected to City's potable water distribution system; used strictly for minor landscape irrigation purposes

(a) The City also has two other municipal wells that are either out of service or inactive: Freeway Well (W3) is out of service due to groundwater contamination caused by others; Sharon Park Well (W6) is inactive due to severe sanding.

(b) Change in status approved by California Department of Public Health on July 20, 2005.

The Farmers Lane wells are located near the mouth of Bennett Valley on the east side of the Santa Rosa Plain Sub-basin. The major geologic formations underlying the vicinity of the Farmers Lane wells include the Younger Alluvium, the Older Alluvium, the Glen Ellen and Huichica Formations, the Sonoma Volcanics, the Wilson Grove Formation and the Petaluma Formation. The wells are located within a major regional fault zone comprised of the Rodgers Creek and Healdsburg fault zones. The wells are 800 and 1,000 feet deep and draw water from the deep aquifer which is predominantly Sonoma Volcanics. Water levels observed in the Farmers Lane wells have been in an artesian condition for several years. A groundwater treatment system has been constructed at the site of the Farmers Lane wells for iron and manganese removal and disinfection.

Total groundwater pumpage from these municipal wells was only 129 af from 2000 to 2006 (an average of only 21 afy). Due to the conversion of the City's municipal wells from emergency stand-by status to production status, dry hydrologic conditions in 2007, and a SWRCB Order requiring the SCWA to reduce diversions from the Russian River by 15% compared to 2004 diversions, the City pumped 829 af in 2007 from Farmers Lane Wells Nos. 1 and 2 to supplement water supplies from SCWA to meet demands.

The City does not have any municipal wells within the Rincon Valley Sub-basin or the Kenwood Valley Groundwater Basin. Table 12 summarizes the City's municipal groundwater pumpage in the last seven years.

Table 12 – Amount of Municipal Groundwater Pumped by the City of Santa Rosa in Past Seven Years

Basin/Sub-basin Name	Historical Municipal Groundwater Pumpage (afy)						
	2001	2002	2003	2004	2005	2006	2007
Santa Rosa Valley Groundwater Basin: Santa Rosa Plain Sub-basin[(a)]	Total estimated municipal pumpage from 2000 to June 2006 was 161 af, or an average of about 27 afy						829
Santa Rosa Valley Groundwater Basin: Rincon Valley Sub-basin	The City does not have any wells or pump any groundwater from this sub-basin						
Kenwood Valley Groundwater Basin	The City does not have any wells or pump any groundwater from this groundwater basin						

(a) Source: Table 4-4, City of Santa Rosa 2005 Urban Water Management Plan, June 2006.

2.4.4.2.5 Projected SCWA Groundwater Pumpage

Table 13 shows the projected groundwater pumpage by SCWA. As shown, projected pumpage is expected to be 3,870 afy in the future through 2030 from the Agency's three existing production wells, which do not materially provide supply to the City. There are currently no known plans for additional SCWA production wells within the Santa Rosa Plain Sub-basin or any new SCWA production wells within the Rincon Valley Sub-basin or Kenwood Valley Groundwater Basin.

Table 13 – Amount of Groundwater Projected to be Pumped by the Sonoma County Water Agency

Basin/Sub-basin Name	Projected Groundwater Pumpage (afy)				
	2010	2015	2020	2025	2030
Santa Rosa Valley Groundwater Basin: Santa Rosa Plain Sub-basin[(a)]	3,870	3,870	3,870	3,870	3,870
Santa Rosa Valley Groundwater Basin: Rincon Valley Sub-basin	The Agency does not plan to install any wells or pump any groundwater from this sub-basin in the future				
Kenwood Valley Groundwater Basin	The Agency does not plan to install any wells or pump any groundwater from this basin in the future				

(a) Source: Table 4-3, Sonoma County Water Agency 2005 Urban Water Management Plan, December 2006.

2.4.4.2.6 Projected City Municipal Groundwater Pumpage

The City's Farmers Lane Wells No. 1 and 2 have begun to provide supply to the City's potable water system to supplement supplies obtained from SCWA, and to provide supply during high demand periods. Before the City obtained surface water

supplies from SCWA, the Farmers Lane wells contributed a significant portion of the groundwater supplies required to meet the City's demands. Of the City's roughly 2,870 afy historical groundwater demand, it is estimated that the Farmers Lane Wells supplied about 1,720 afy[29].

In the future, it is anticipated that the Farmers Lane wells may be operated as much as 40 to 60 percent of the time at a pumping rate of about 2,400 gpm, which would equate to an annual pumpage quantity of approximately 1,550 to 2,300 afy (in 2007, 829 af was pumped from the Farmers Lane wells). This projected pumpage quantity is less than the City's historical groundwater pumpage of 2,870 afy. There are currently no plans for additional active City production wells within the Santa Rosa Plain Sub-basin or any new City production wells within the Rincon Valley Sub-basin or Kenwood Valley Groundwater Basin. Table 14 presents the amount of groundwater projected to be pumped by the City.

Table 14 – Amount of Groundwater Projected to be Pumped by the City

Basin/Sub-basin Name	Projected Future Municipal Groundwater Pumpage (afy)				
	2010	2015	2020	2025	2030
Santa Rosa Valley Groundwater Basin: Santa Rosa Plain Sub-basin[(a)]	900	1,800	2,300	2,300	2,300
Santa Rosa Valley Groundwater Basin: Rincon Valley Sub-basin	The City does not plan to pump groundwater from this sub-basin in the future				
Kenwood Valley Groundwater Basin	The City does not plan to pump groundwater from this basin in the future				

(a) Source: Table 4-4, City of Santa Rosa 2005 Urban Water Management Plan, June 2006.

It should be noted that the City has a Mitigation and Monitoring Program in place for the Farmers Lane wells that includes monitoring of groundwater levels in the vicinity of the Farmers Lane wells and modified pumping rates if an adverse decline in groundwater levels and/or other adverse effects are detected.

The groundwater basin does not appear to have physical constraints for pumping if used as planned to provide supplemental and peaking capacity to the primary supply source provided by the SCWA, in addition to utilizing the groundwater basin as an emergency supply source. The long-term sustainable yield of the groundwater basin has not been specifically determined, and if new and existing groundwater wells were developed as a production source, additional study of the sustainable yield would need to be conducted.

2.4.4.3 Analysis of Sufficiency of Groundwater to meet Projected Water Demands Associated with the Project

Based on available information, this WSA finds that the City's existing groundwater supply of 2,300 afy, in combination with the City's other supplies, is adequate and that no additional groundwater supply is needed to meet the projected

[29] Technical Memorandum, Evaluation of Potential Impacts Associated with Increased Groundwater Production from Farmers Lane Wells W4-1 and W4-2, prepared by West Yost & Associates, July 22, 2004.

demand of the Project. This finding is based on the following facts regarding the overall Santa Rosa Plain Sub-basin and the area of the sub-basin underlying the City:

- As stated in the DWR Bulletin 118 groundwater basin description of the Santa Rosa Plain Sub-basin, last updated in February 2004, the Santa Rosa Plain Sub-basin as a whole is about in balance, with increased groundwater levels in the northeast contrasting with decreased groundwater levels in the south (as illustrated by current water level measurements from the Rohnert Park wells, groundwater levels in the southern portion of this sub-basin are no longer declining, and have in fact risen dramatically over the last few years).
- Review of groundwater levels in DWR monitored wells located throughout the Santa Rosa Plain Sub-basin, City of Santa Rosa wells, and SCWA production wells indicates that most wells have had either increasing or stable groundwater levels for the last 17 to 29 years. Also, more recently, groundwater levels as measured in the Rohnert Park wells have also shown a significant increase, probably a result of Rohnert Park's increased reliance on supplies from the SCWA. These increasing or stable groundwater levels are a key indication that the Santa Rosa Plain Sub-basin is in a state of equilibrium (balanced condition), and that it is not in an overdraft condition.
- DWR monitored wells with historically decreasing groundwater levels, including two actively monitored wells and five historically monitored wells, primarily located southwest of the City near the western fringe of the Santa Rosa Plain Sub-basin, are likely indicative of localized groundwater pumping conditions and are not indicative of overall sub-basin conditions.
- Groundwater levels in DWR actively monitored wells in and adjacent to the City have been either increasing or stable for the last 17 to 29 years indicating that the portion of the Santa Rosa Plain Sub-basin underlying the City is in balance.
- Some DWR monitored wells have had slightly decreasing water levels in the last two years (2007 and 2008). These declines in groundwater levels are indicative of the recent dry hydrologic conditions and a 2007 SWRCB Order requiring the SCWA to reduce diversions from the Russian River by 15% compared to 2004 diversions, thus requiring increased groundwater pumpage by private individuals and increased pumpage from some agencies to supplement their supplies from SCWA. These recent groundwater level decreases are considered to be indicative of the dry year conditions in 2007 and 2008, the natural hydrologic cycles that occur over time, and the corresponding conjunctive use of the groundwater basin, and are not considered to be a concern.
- Pumpage by SCWA from the Santa Rosa Sub-basin over the past seven years has ranged from about 1,600 to 5,900 afy. Future pumpage by SCWA is anticipated to be about 3,870 afy.
- In the years before the City began receiving surface water from SCWA, the City relied exclusively on groundwater to meet its water demands and historical municipal groundwater pumpage was estimated to be up to about 2,870 afy. Since the City began receiving surface water from SCWA, groundwater has been considered by the City to be an emergency supply, with only very little use for some localized landscape irrigation. However, in

2007, the City began pumping the Farmers Lane wells to supplement supplies from SCWA, and to assist in meeting high demand periods. In the future, it is anticipated that the City's Farmers Lane wells may be operated as much as 40 to 60 percent of the time at a pumping rate of about 2,400 gpm, which would equate to an annual pumpage quantity of approximately 1,550 to 2,300 afy. This projected municipal pumpage will be less than the City's maximum historical groundwater pumpage (2,870 afy) and less that the estimated annual groundwater recharge in the area from which the Farmers Lane wells extract groundwater (2,500 afy).

Based on these facts, the City's existing groundwater supply of 2,300 afy, in combination with the City's other supplies, is considered to be adequate and that no additional groundwater supply is needed to meet the projected demand of the Project.

2.4.5 Recycled Water

The City's Subregional System is one of the largest recyclers of water in the world. The recycled water that leaves the treatment plant is high-quality, tertiary treated water that is approved for many reuse purposes, including irrigation of landscapes, agricultural crops, vineyards, playgrounds, golf courses, and public parks. The Subregional System's existing urban reuse program irrigates many schools, parks and businesses in the City and in Rohnert Park, including Sonoma State University. In the City, recycled water is used at sites including Finley Park, A Place to Play sports complex and Oakmont Golf Course. In 2007, 6,400 acres of farmlands, vineyards, and public and private urban landscaping were irrigated with 2.5 billion gallons of recycled water. Of that, 85% was used for agricultural purposes. The irrigation system is supported by storage reservoirs that can hold over 1.7 billion gallons of water, which allows the system to meet peak, hot summer day irrigation requirements.

2.4.5.1 Historical and Existing Urban Recycled Water Use

The City's current and historic use of recycled water has been limited to areas within close proximity to the Subregional System's distribution network. The City has historically used up to approximately 350 afy of recycled water for urban landscape irrigation. Due to operational issues starting in 2006, recycled water use has dropped to an average of approximately 130 afy. Operational changes and improvements are currently being implemented and recycled water use is anticipated to return to previous usage.

Table 15, based on City 2005 UWMP table 5-4, illustrates existing and planned recycled water use for the entire Subregional System. The table footnotes clarify the portion of current and future landscape irrigation serving the City.

Table 15 – Subregional System Recycled Agricultural and Urban Water Uses – Existing and Planned (afy)

Type of Use	Treatment Level	2005	2010	2015	2020	2025	2030
Agriculture[a]	Tertiary	5,200	5,200	5,200	5,200	N/A[e]	N/A[e]
Landscape[b]	Tertiary	1,594	1,595	1,650	1,700	N/A[e]	N/A[e]
Geysers Recharge Project[c]	Tertiary	12,300	12,300	12,300	12,300	N/A[e]	N/A[e]
Other[d]	Tertiary	0	0	2,476	5,340	N/A[e]	N/A[e]
Total	Tertiary	19,094	19,095	21,626	24,540	N/A[e]	N/A[e]

Source: IRWP: Recycled Water Master Plan Tables 3, 4, and 5 (CH2MHILL and Winzler and Kelly, 2004)
[a] Agricultural use may offset groundwater pumping.
[b] Urban landscape use offsets potable water demand. 344 afy of current and 450 afy of 2020 are from the City.
[c] This type of use does not offset potable water use.
[d] The IRWP identified a range of options for additional recycled water use, including increased urban reuse, increased agriculture irrigation, and increased Geyser's Recharge. This category may be the source of further urban reuse in the City.
[e] Not available.

In December 2007, the City approved the Santa Rosa Urban Reuse Project which serves 3,000 afy of recycled water to current and future approved water uses, primarily landscape irrigation, and selected Phase 1West as the first phase of the project to be implemented. This project will be implemented in phases through approximately 2020. Phase 1 West is designed to provide up to 750 afy of recycled water, and the City has begun design services for the first phase of this project which will provide approximately 60 afy of recycled water. Section 2.5.1.3 discusses development of this additional recycled water in detail.

2.4.6 Water Conservation

Demand management is an integral part of the City's long-term water management strategy. The City is committed to integrating water conservation into future supply and demand solutions for both the water system and the wastewater treatment/reuse system.

2.4.6.1 Historic and Existing Water Conservation

The City has been implementing a water conservation program since the 1976-1977 drought and the program was further established in the early 90's when full time permanent staff was hired for the program. In 1998, the City became a signatory to the California Urban Water Conservation Council's (CUWCC) Memorandum of Understanding (MOU) Regarding Urban Water Conservation. As a signatory, the City has fully implemented the Best Management Practices (BMPs) defined in the MOU. Table 16 summarizes the City's implementation of the CUWCC BMPs.

Table 16 - City Implementation of California Urban Water Conservation Council Best Management Practices

Best Management Practices, BMP		City of Santa Rosa
BMP 01:	Water Survey Programs for Single-Family and Multi-Family Residential Customers	✓
BMP 02:	Residential Plumbing Retrofit	✓
BMP 03:	System Water Audits, Leak Detection, and Repair	✓
BMP 04:	Metering with Commodity Rates for all New Connections and Retrofit of Existing	✓
BMP 05:	Large Landscape Conservation Programs and Incentives	✓
BMP 06:	High-Efficiency Washing Machine Rebate Programs	✓
BMP 07:	Public Education Programs	✓
BMP 08:	School Education Programs	✓
BMP 09:	Conservation Programs for Commercial, Industrial, and Institutional Accounts	✓
BMP 10:	Wholesale Agency Assistance Programs	NA
BMP 11:	Conservation Pricing	✓
BMP 12:	Conservation Coordinator	✓
BMP 13:	Water Waste Prohibition	✓
BMP 14:	Residential ULFT Replacement Programs	✓

As part of the implementation of the BMPs, the City offers technical support and incentives to all its customer classes: single family residential, multi-family residential, commercial/industrial/institutional customers, and large landscape customers. As illustrated in Table 17, from 1994 – 2007, the City has saved a total of 26,905 af of water due to implementation of all of the applicable BMPs.

Table 17 – CUWCC Water Savings Report Gross Water Savings 1994 – 2007 All Water Savings in AF

	BMP 1	BMP 2	BMP 4	BMP 5	BMP 6	BMP 9	BMP 9a*	BMP 14	Total
1994	15	0	0	0	0	37	10	44	106
1995	49	0	0	0	0	9	12	149	219
1996	83	0	0	0	0	41	18	295	437
1997	150	0	0	0	0	166	39	577	932
1998	192	0	0	0	0	121	53	745	1,111
1999	195	28	0	22	10	302	53	842	1,452
2000	183	42	0	41	17	670	53	885	1,891
2001	268	91	0	912	19	538	73	1,217	3,118
2002	258	139	0	908	20	523	82	1,291	3,221
2003	241	145	0	979	33	502	93	1,401	3,394
2004	212	152	0	977	48	666	94	1,401	3,550
2005	191	157	0	1,434	62	322	94	1,401	3,661
2006	164	163	0	1,623	80	288	94	1,401	3,813
2007	142	212	0	1,769	96	270	94	1,401	3,984
Total	2,343	1,129	0	8,665	385	4,455	862	13,050	26,905

* As of December 2006, the CUWCC coverage reports now include savings for BMP 09a. Past reports showed savings of 0 each year.

The aggressive conservation efforts of the past 17 years in the City have resulted in a current annual savings of about 3,984 afy. Without this effort, City water use would be 15% higher than current demand. This effort resulted in implementation of most BMPs beyond the target established by the CUWCC, and for some BMPs further sustainable savings cannot be achieved because participation levels have been so high.

2.5 Future Supplies

10911. (a) If, as a result of its assessment, the public water system concludes that its water supplies are, or will be, insufficient, the public water system shall provide to the city or county its plans for acquiring additional water supplies, setting forth the measures that are being undertaken to acquire and develop those water supplies. If the city or county, if either is required to comply with this part pursuant to subdivision (b), concludes as a result of its assessment, that water supplies are, or will be, insufficient, the city or county shall include in its water supply assessment its plans for acquiring additional water supplies, setting forth the measures that are being undertaken to acquire and develop those water supplies. Those plans may include, but are not limited to, information concerning all of the following:

(1) The estimated total costs, and the proposed method of financing the costs, associated with acquiring the additional water supplies.

(2) All federal, state, and local permits, approvals, or entitlements that are anticipated to be required in order to acquire and develop the additional water supplies.

(3) Based on the considerations set forth in paragraphs (1) and (2), the estimated timeframes within which the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), expects to be able to acquire additional water supplies.

Existing water supplies are projected to meet all demands through approximately 2018, or through 2015 if the City, through discretionary action, connects a significant number of water services that are now served by private wells. Because existing supplies are not expected to be sufficient to provide all water supply for the Project, this WSA sets forth the measures being undertaken to acquire additional water supplies including the information required by Section 10911 above.

Additional supply beyond the Restructured Agreement entitlement of 29,100 afy, local supply of 2,300 afy and recycled supply of approximately 410 afy (current use of 350 afy plus 60 afy from first phase of expanded urban reuse) will be needed before the end of the 20 year period evaluated in this WSA is reached.

The following discussion sections describe the City's plans for acquiring the additional water supplies, setting forth the measures that are being undertaken to acquire and develop those water supplies, including, but not limited to, estimated costs, proposed methods of financing, information on permits and approvals necessary, and the estimated time frames to acquire the additional water supplies.

2.5.1 Additional Supply Overview

The City's additional water supply will be met from the 3,000 afy recycled water project, which is ready to implement when needed, and by any combination of the following sources which are all under evaluation or development: additional entitlement of 1,830 afy from SCWA, additional local groundwater, additional recycled water beyond the 3,000 afy recycled water project, and/or more stringent water conservation measures**.**

Table 18, based on Table 4-6 of the City 2005 UWMP, illustrates the projected volumes of water available for use by the City, by source of supply through 2030. The category "Additional supplies" in the table refers to the mix of sources described in detail in this section.

Table 18 - Existing and Additional Water Supplies

Water Supply Sources	2005	2010	2015	2020	2025	2030
Sonoma County Water Agency[a]	25,891[e]	28,184[e]	29,100	29,100	29,100	29,100
City produced groundwater[b]	0	900	1,800	2,300	2,300	2,300
Recycled water[c]	344	344	400	450	500	550
Additional supplies[d]	0	0	1,169	3,142	5,133	6,536
Total	26,235	29,428	32,469	34,992	37,033	38,486

[a] Water supplied from the Sonoma County Water Agency is based on current Restructured Agreement entitlement.
[b] Based on Mitigated Negative Declaration. October 29, 2004. Farmers Lane Wells Conversion Project.
[c] Recycled water projected is for urban reuse only (not agricultural) and represents the minimum expansion of the existing system; additional recycled water use may be part of the "Other" category in this table.
[d] Pursuant to discussion in this section of the WSA, this increment of water can come from a variety of sources: Additional recycled water use, additional SCWA supplies as identified in the SCWA's 2005 UWMP, additional local groundwater use, and/or more stringent conservation measures.
[e] 29,100 afy is available from SCWA. These numbers are estimated actual use.

2.5.1.1 Additional Wholesale Water Supply – SCWA

Table 3-4 of the SCWA 2005 UWMP incorporates 30,930 afy of annual entitlement for the City, which includes 1,830 afy over the City's current 29,100 afy entitlement[30]. In April 2007, the City's Board of Public Utilities adopted Resolution 883, requesting not less than 30,930 afy of annual entitlement from SCWA to assist in meeting future water supply needs for the City's General Plan.

Estimated Costs and Proposed Financing: The financing and authorization to construct the facilities to achieve the increased diversions is in the Restructured Agreement.

Permits and Approvals Necessary: SCWA has submitted petitions and a new water rights application to the SWRCB to increase its Russian River diversions from 75,000 afy to 101,000 afy, and its maximum rate of diversion from 180 cubic feet per second (cfs) to 252 cfs. SCWA intends to release the draft Environmental Impact Report (EIR) for the project, which will allow SCWA to develop the transmission capacity and water rights to deliver this additional supply, by the end of 2008.

Estimated Time Frame to Acquire Supplies: Tables 4-9, 4-10, and 4-11 for the SCWA 2005 UWMP projects that the capital projects to provide the diversion facilities and transmission capacity will be complete by 2020 and that the SWRCB approval of the new water rights application will be complete by 2016.

2.5.1.2 Additional Groundwater Supply

In March 1998, the City completed a Well Field Study identifying implementation steps to develop an additional 8.7 mgd of emergency potable groundwater supply. The City has initiated this Program, and potential, future emergency well sites are being identified and evaluated. In evaluating the sites for new emergency groundwater wells,

[30] The approval of the SCWA 2005 Urban Water Management Plan was vacated by the Sonoma County Superior Court on October 28, 2008, and the Plan was remanded to SCWA on other grounds not affecting the validity of Table 3-4.

the City is also considering the potential for additional production wells (in addition to other potential supply sources, such as recycled water) which may be necessary to supplement SCWA supplies and provide the City with adequate supplies to meet future demands.

Estimated Costs and Proposed Financing: Since the mid 1990's, the City has had an adopted Capital Improvement Program for the development of the City's groundwater resources.

Permits and Approvals Necessary: If additional production well sites are identified, appropriate CEQA documentation will need to be developed and adopted. Appropriate permits and approvals for production wells would need to be obtained from DPH.

Estimated Time Frame to Acquire Supplies: At this time, there are no projected timelines for development of additional production well sites. However, the City has already conducted exploratory drilling at two locations and is poised to conduct additional exploratory drilling at three other sites. A timeline for the development of additional production wells will be prepared after the results from these three additional exploratory borings are analyzed, and it is determined whether or not additional exploratory sites must be investigated.

2.5.1.3 Additional Recycled Water Use

Because the City is the owner and operator of the Subregional System, the recycled water resources from the Subregional System are available within the City UGB to serve sites currently served by potable water.

In 2001, the City undertook the Incremental Recycled Water Program (IRWP), which includes plans for recycled water urban reuse efforts. The IRWP outlines a water recycling alternative that can replace the City's potable water sources (not including private groundwater supply sources) up to a maximum of 2,200 afy upon implementation and 4,400 afy by 2020.

The already approved Urban Reuse Project can supply 3,000 afy, as described below, and is the first step in implementing the urban reuse element of the IRWP. Per the IRWP, the total recycled water available in 2020 will be up to 6,600 afy, which is greater than the potable offset demand for that year; the extra recycled water may be available to supply irrigation and industrial connections after 2020, including through the evaluation period of this WSA.

In April 2005, the City began work on the City's Urban Reuse Project expansion conceptual plan, which analyzed several alternatives for expanded urban reuse within the City service area. In September 2006, the City Board of Public Utilities approved contracts for pre-design of a phased urban reuse project with ultimate service to the majority of the south and west portions of the City, and a total delivery of 3,000 afy to sites which would otherwise be served by potable water.

Estimated Costs and Proposed Financing: In the January 2007 Urban Reuse Feasibility Study, the cost of implementing the 3,000 afy Urban Reuse project is estimated to be a total of $119 million, in 2006 dollars. The City has included funding for the project in the

structure of the water and wastewater demand fees, for which a study was past performed in March 2007. The cost of implementing recycled water beyond the 3,000 afy project has not yet been determined.

Permits and Approvals Necessary: All necessary components and approvals are in place for the 3,000 afy Urban Reuse project. In November 2003 the IRWP program EIR was certified, and in March 2004 the Final Master Plan was adopted. The CEQA Checklist for the Urban Reuse project was approved by the City in December 2007. In September 2007, the City adopted a Recycled Water Ordinance, granting the City the authority to require new connections to the water system to use recycled water for appropriate uses. For recycled water beyond the 3,000 afy project, the City would need to complete CEQA analysis at the project level.

Estimated Time Frame to Acquire Supplies: This project can be implemented in 4 phases from 2009 – 2015/2020, each resulting in approximately 750 afy of potable offset. In December 2007, the City Board of Public Utilities and City Council approved Phase 1 West of the Urban Reuse Project, providing up to 750 afy of recycled water. Design of the initial phase of the project has begun and construction of this initial phase is anticipated to begin in 2009. The phased nature of the urban reuse alternative allows City policy makers to develop this water supply source incrementally as more supply is needed, while continuing to evaluate other potentially more cost effective water supply sources for future water supply needs. Recycled water development beyond the 3,000 afy project would be after completion of this project, most likely between 2015-2020.

2.5.1.4 Additional Water Conservation

Future conservation efforts will focus first on sustaining the savings already achieved, as described in Section 2.4.6, and secondly on achieving additional savings from new and emerging technologies, such as high-efficiency toilets and “smart” irrigation controllers. Actual sustainable savings are currently being analyzed as part of the City’s implementation of these measures and will be updated once complete. The actual savings realized from these measures will become part of the “Additional supplies” category of Table 18 in this WSA.

Estimated Costs and Proposed Financing: Funding for ongoing conservation efforts is an integral component of the City budget. Annual funding includes approximately $600,000 per year to operate the Water Conservation Program. In addition, the City has a $1 million Capital Improvement Program to provide for the replacement of inefficient water using hardware with water conserving hardware. The on-going funding for the water conservation program is funded by water and wastewater demand fees as well as water rates.

Permits and Approvals Necessary: Water Conservation program approval and direction is provided by the City’s Board of Public Utilities. Changes to the City Code, if needed, are approved by the City Council. It is not anticipated that any further permits or approvals would be needed.

Estimated Time Frame to Acquire Supplies: The City expects to achieve additional sustainable savings of 900 – 1,100 afy by 2020, and an extra 300 – 500 by 2030. Because these technologies do not have established sustainable savings factors and the City's programs implementing these technologies began in 2007, the savings figures in this WSA are estimates.

2.6 Dry Year Analysis

Supplies for single and multiple dry years were fully analyzed in the City 2005 UWMP. Table 19, based on City 2005 UWMP Table 4-13 and SCWA 2005 UWMP tables 4-6 through 4-8, lists the years on which the analysis was based.

Table 19 – Basis of Dry Year Analysis

Water Year Type	Base Year(s)
Normal Water Year	1962
Single-Dry Water Year	1977
Multiple-Dry Water Years	1990 – 1993

Table 20, based on City 2005 UWMP Table 4-8 with year 4 update from SCWA 2005 UWMP, shows the City's supplies in a single dry year and multiple dry years at 2030. Though SCWA 2005 UWMP analysis shows a SCWA reduction of up to 15% in a single dry year, because allocation among contractors is determined by the Allocation Methodology of Section 3.5 of the Restructured Agreement, no water supply deficiency in Santa Rosa is expected due to dry year conditions in either analysis[31]. Full discussion of the Allocation Methodology is in Section 2.4.3 of this WSA.

Table 20 – Year 2030 Supply Reliability – Percent of Normal (afy)

		Multiple-Dry Water Years			
Sources	Single-Dry Water Year	Year 1	Year 2	Year 3	Year 4
Sonoma County Water Agency[a]	29,100	29,100	29,100	29,100	29,100
Groundwater wells	1,550	1,550	1,550	1,550	1,550
Recycled water	550	550	550	550	550
Additional supplies[b]	6,536	6,536	6,536	6,536	6,536
TOTAL	37,736	37,736	37,736	37,736	37,736
Percent of Normal	100	100	100	100	100

[a] Source: SCWA UWMP (2005) and given that Section 3.5 of the Restructured Agreement would determine allocation among SCWA contractors.

[b] Pursuant to discussion in this WSA, this increment of water can come from a variety of sources: SCWA supplies which may be available to meet City demands, additional recycled water use, additional local groundwater use, and/or more stringent water conservation. If this increment of water is met with recycled water, local groundwater or conservation, the full increment will be available; if it is met with SCWA supply, it is likely to be available based on SCWA UWMP dry year analysis.

[31] Again, the approval of the SCWA 2005 Urban Water Management Plan was vacated by the Sonoma County Superior Court on October 28, 2008, and the Plan was remanded to SCWA on other grounds not affecting the validity of the dry year analyses.

2.7 Demands

As discussed in Section 2.3 of this WSA, the demand projections in the City 2005 UWMP were based on the SCWA Demand Projections. SCWA Demand Projections for the City are for water supply for normal weather conditions. Table 21 is based on the City 2005 UWMP Table 3-4.

Table 21 - Santa Rosa Historical and Projected Water Demand (afy)

Water Use	2000	2005	2010	2015	2020	2025	2030
Water use, normal weather conditions	23,312	26,235	28,528	30,669	32,692	34,733	36,186

The demand projections in the City 2005 UWMP and Supply Analysis include the assumption that the City will ultimately provide over 2,000 afy of water supply to private water users (currently on wells) for potable water needs. (Supply Analysis, p. 18-19). The decision to provide this supply would be a discretionary action of the City. The following discussion provides background on this increment of projected demand.

Since 2000, the City has been asked to connect two neighborhoods (within the City water service area) that had previously been served by private wells to City water. The request was made because of contamination of the groundwater, making it unsuitable for potable use (though it was still suitable for landscape irrigation). The decision to provide water service in these cases was a discretionary action on the part of the City. Several alternatives had been identified, but City water connection was the least costly and most expedient.

DPH has identified a significant number of current private groundwater wells that are in close proximity to known groundwater contamination sites. Because the City has been asked to provide water service in the past in such circumstances, it is possible that the City will be asked to provide water service in the future if groundwater contamination becomes a public health issue.

2.8 Sufficiency Determination

2.8.1 Supply and Demand Comparison

Table 22 compares normal year supply with projected demand. Table 23 compares supply during a single-dry and a multiple dry year condition with projected demand. Based on this comparison, at no time during the twenty-year assessment period of this WSA is a shortage in supply anticipated during non-drought conditions.

The evaluation of surface water supply sources during a single dry year set forth in table 4.7 the SCWA 2005 UWMP shows a SCWA reduction of up to 15%. Allocation among contractors during such conditions is determined by the Allocation Methodology of Section 3.5 of the Restructured Agreement which is described in detail in Section 2.4.5 of this WSA. Due to this Shortage Methodology it is not likely that drought would reduce the volume of surface water available to the City because significant water would be in storage, even in dry year conditions, which SCWA is entitled to withdraw.

In addition, the City's projected demands include over 2,000 afy of water service that the City has the discretion to serve or not to serve as described previously in Section 2.7 of this WSA.

Table 22 – Santa Rosa Normal Year Supply and Demand (afy)

Water Supply or Demand	2005	2010	2015	2020	2025	2030
Water Supply, Non-Drought Year	26,235	29,428	32,469	34,992	37,033	38,486
Water Demand	26,235	28,528	30,669	32,692	34,733	36,186

Table 23 – Santa Rosa Single and Multiple Dry Year(s) Supply and Demand (afy)

Water Supply or Demand	2005	2010	2015	2020	2025	2028
Water Supply, Single and Multiple Dry Year(s)	26,235	29,428[b]	32,469	34,992	37,033	38,486
Water Demand	26,235	28,528	30,669	32,692	34,733	36,186

[b] – Supply reported in City 2005 UWMP assumes use of 900 af of groundwater when up to 2,300 af is available.

2.8.2 Projection of Demand for the Project

The water demand for the Project is projected to be a maximum of 1,040 afy.

The projected water demand for the Project is determined by using Residential Equivalency Factors (REFs) consistent with the land use classifications of the Project and zoning code, and with those set forth in Code Section 10912 (a). These classifications are: residential (attached and detached), retail (shopping center/business establishment), office (commercial office buildings), industrial (industrial park/processing plant/ manufacturing), public/institutional, and park or public landscape.

Table 24 shows the number of REFs in each classification for the Project.

Table 24 - Residential Equivalency Factors (REF) for the Project

Land Use Category	Area per REF (SF)	Project Area (SF)	Residential Dwelling Units	Residential Equivalency Factors
Residential Detached	N/A	N/A	3,396	3,396
Residential Attached	N/A	N/A	600	400
Retail	1,000	(2,447,468)	N/A	(2,447)
Office	500	237,697	N/A	475
Industrial	1,300	1,513,806	N/A	1,165
Public/Institutional	500	(93,561)	N/A	(187)
Park/public landscape	2,819	217,800	N/A	77
Total		(571,726)	3,996	2,879

The City's projected residential water use is 110,000 gallons per detached residential unit per year. Attached residential water use includes minimal landscape irrigation and averages 2/3 of the detached residential water use. This is based on an analysis of the past ten years of actual detached and attached residential water use. The REFs for the non-residential use categories are based on land use categories and equivalent water use per Code section 10912(a).

Therefore, the annual water demand for the Project's developed area is 110,000 gallons per REF multiplied by 2,879 REFs for the Project, or a total of 316.7 million gallons per year (2,879 X 110,000 gallons), or approximately 972 afy. The total demand for the Project must also include the system standard for unaccounted for water. Unaccounted for water is the difference between water produced and water sold. Typically it is water that is used but unmetered, such as water for system maintenance, fire flow, and leakage from the actual distribution system before the water meter. Based on the City 2005 UWMP, this factor is 7% for the Santa Rosa system. The addition of system unaccounted for water brings the total Project demand to 1,040 afy.

2.8.3 Finding of Sufficiency

California Water Code:
10910 (c)(4) If the city or county is required to comply with this part pursuant to subdivision (b), the water supply assessment for the project shall include a discussion with regard to whether the total projected water supplies, determined to be available by the city or county for the project during normal, single dry, and multiple dry water years during a 20-year projection, will meet the projected water demand associated with the proposed project, in addition to existing and planned future uses, including agricultural and manufacturing uses.

The City has adequate projected water supplies, including existing and additional water supply, to meet existing demands and planned future demands plus the maximum anticipated demand associated with the Project.

The City's projected water supplies for the growth projected in the Project are met from a combination of sources. The primary source of existing supply is contractual entitlement from SCWA as defined in the Restructured Agreement. Supply is also provided from the City's groundwater sources and recycled water.

If all or part of the Project is developed after 2018, or 2015 if the City through discretionary action connects a significant number of water services that are now served by private wells, the demand may be met with existing SCWA supply, existing local groundwater supply sources, or existing recycled water sources; or it may be met with a combination of any of the following additional water supply sources: additional entitlement of 1,830 afy from SCWA, the City's recycled water supplies as defined in the IRWP, possible further utilization of the City's groundwater resources, and conservation efforts.

2.9 Conclusion

California Water Code:
10911. (b) The city or county shall include the water supply assessment provided pursuant to Section 10910, and any information provided pursuant to subdivision (a), in any environmental document prepared for the project pursuant to Division 13 (commencing with Section 21000) of the Public Resources Code.
(c) The city or county may include in any environmental document an evaluation of any information included in that environmental document provided pursuant to subdivision (b). The city or county shall determine, based on the entire record, whether projected water supplies will be sufficient to satisfy the demands of the project, in addition to existing and planned future uses. If the city or county determines that water supplies will not be sufficient, the city or county shall include that determination in its findings for the project.

The City is the public water supplier under SB 610 for the Project (Santa Rosa General Plan 2035).

The water demand for the Project is the increment of increased demand from General Plan 2020 to the Project. While the Project demand was not specifically included in the City 2005 UWMP, the City 2005 UWMP demand projection includes up to 2,000 afy of demand that the City has discretion to serve as discussed in Section 2.3. The Project demand is about half the City's discretionary demand in the City 2005 UWMP, therefore, the demand in the City 2005 UWMP could be used to serve the Project.

At this time, the City finds that based on the entire record of its existing and additional water supplies, projected water supplies will be sufficient to meet the present and future demand associated with the Project, in addition to existing and planned future uses, as that Project demand is projected in Section 2.8.2 of this WSA.

This WSA is valid as of the date approved by the City Council. This WSA is applicable only to the project described in this assessment.

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Appendix A

DWR Well Hydrographs

05N/08W-01L2 Historic Spring Groundwater Levels

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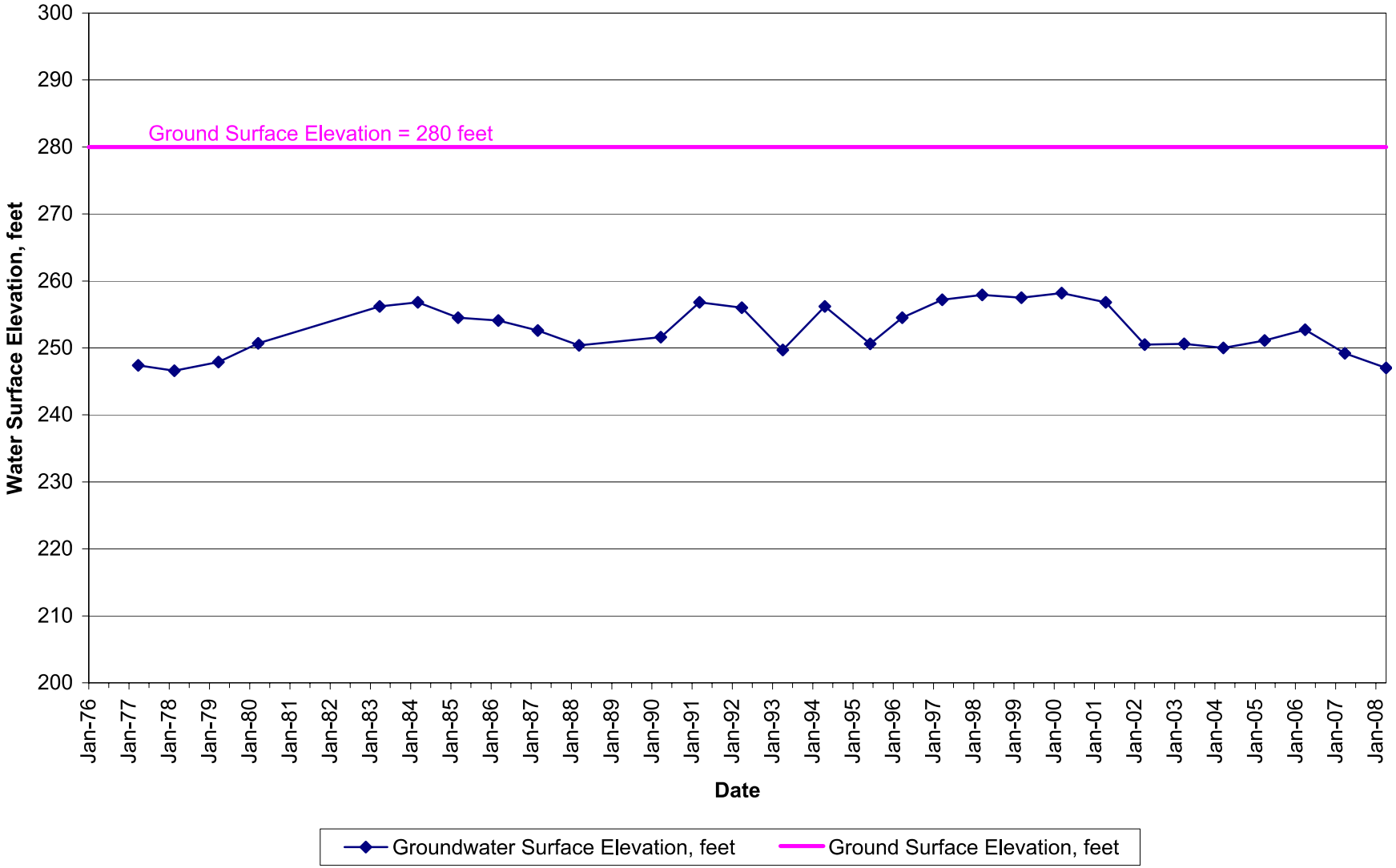

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Last Revised: August 20, 2008

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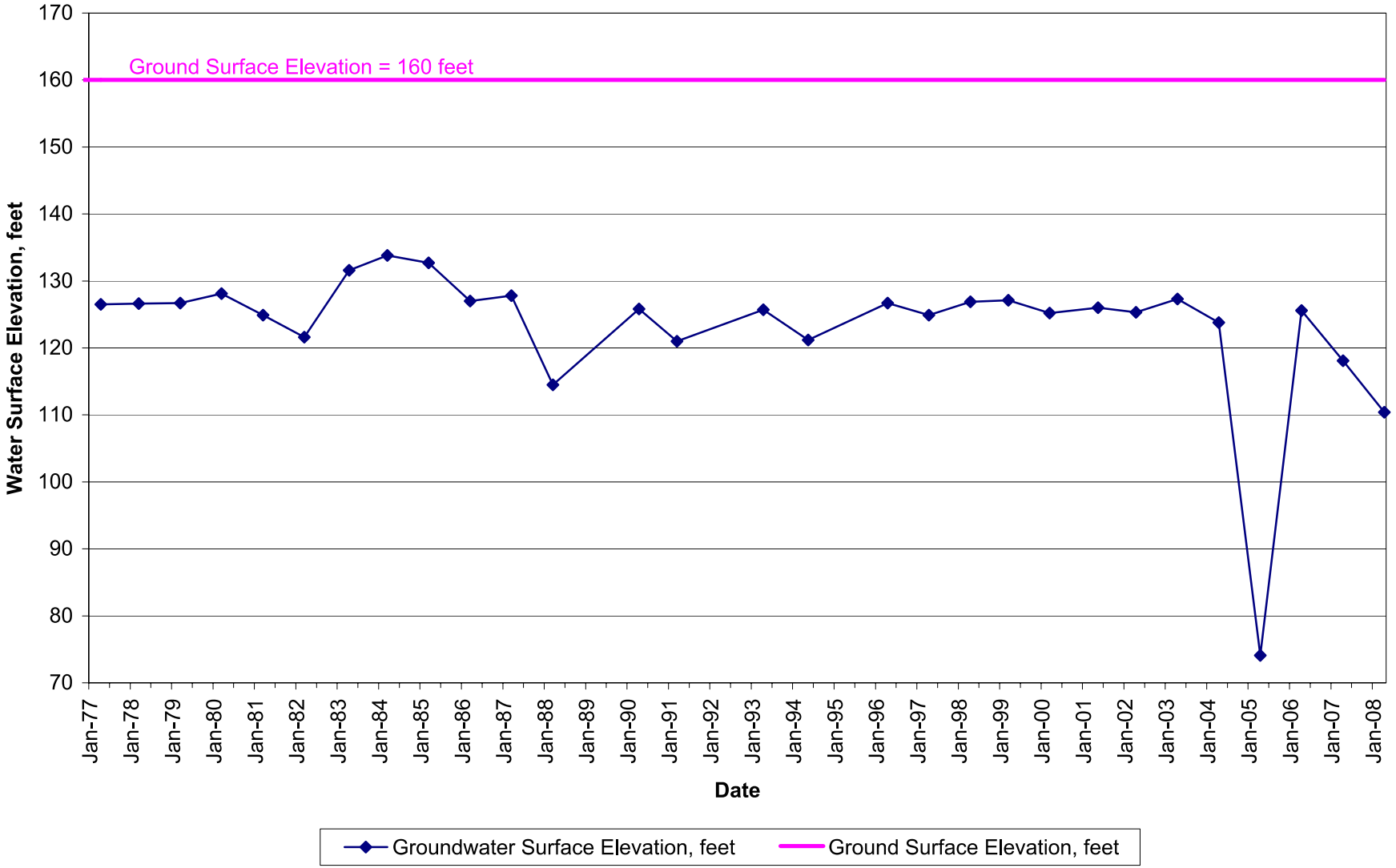

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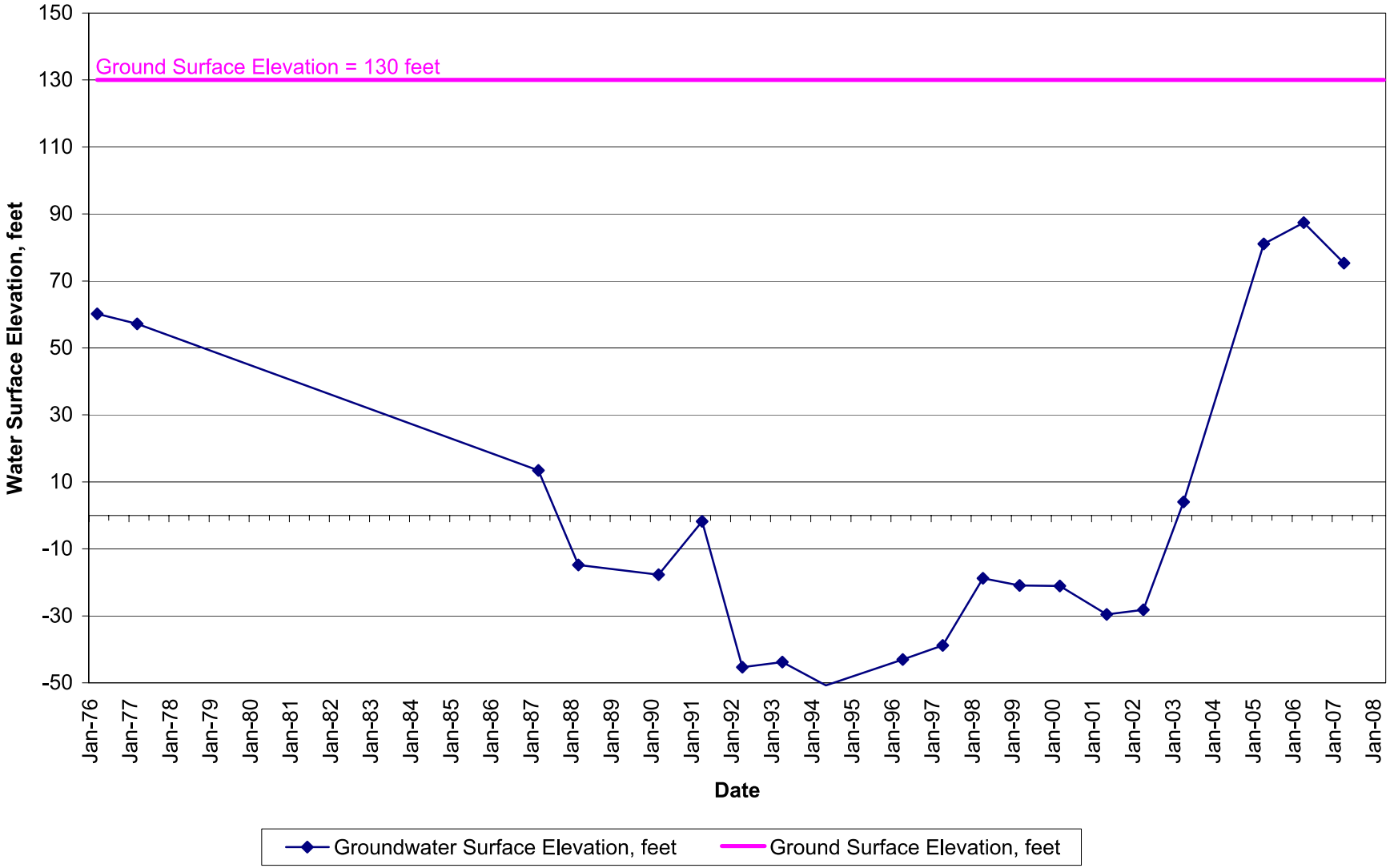

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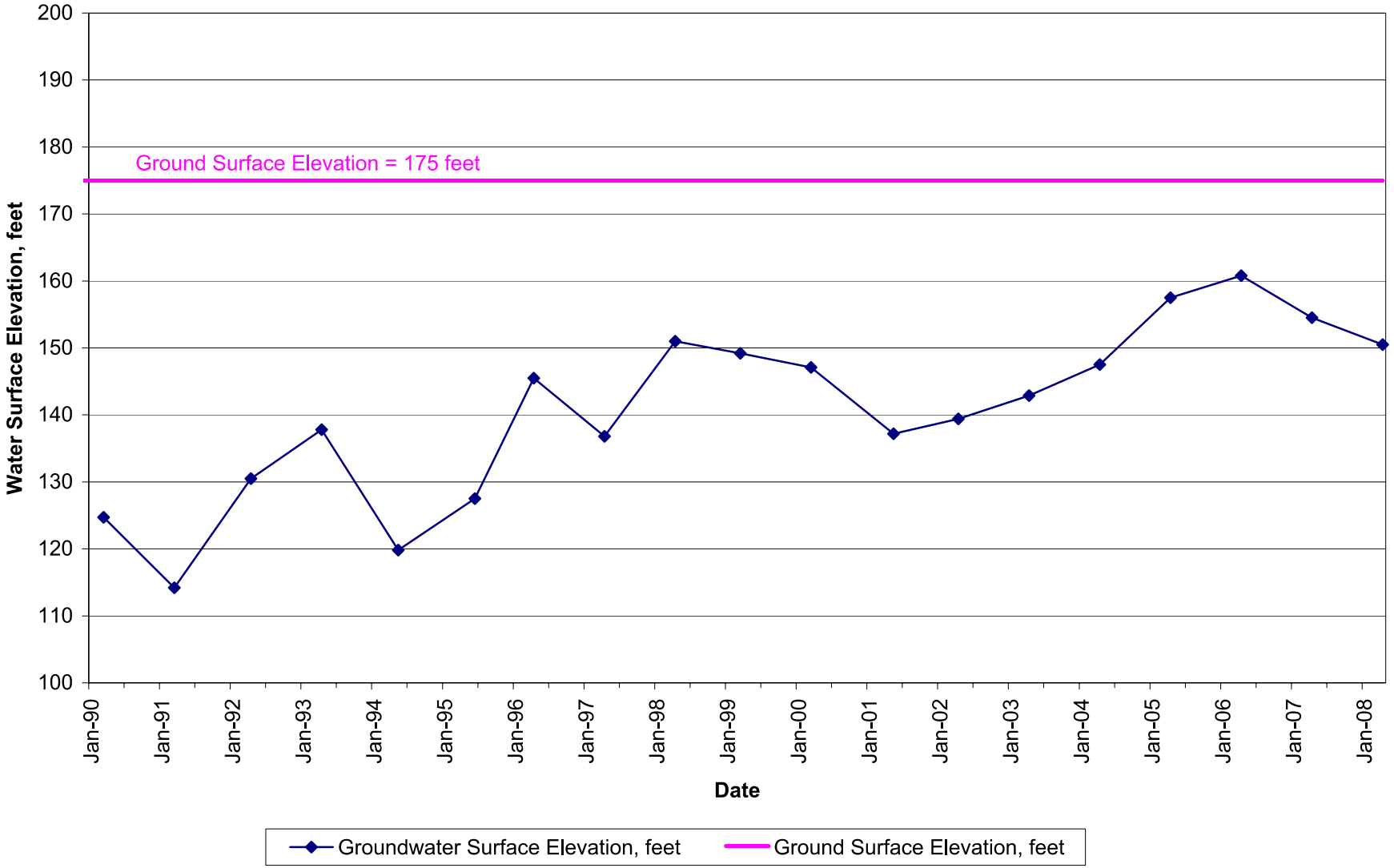

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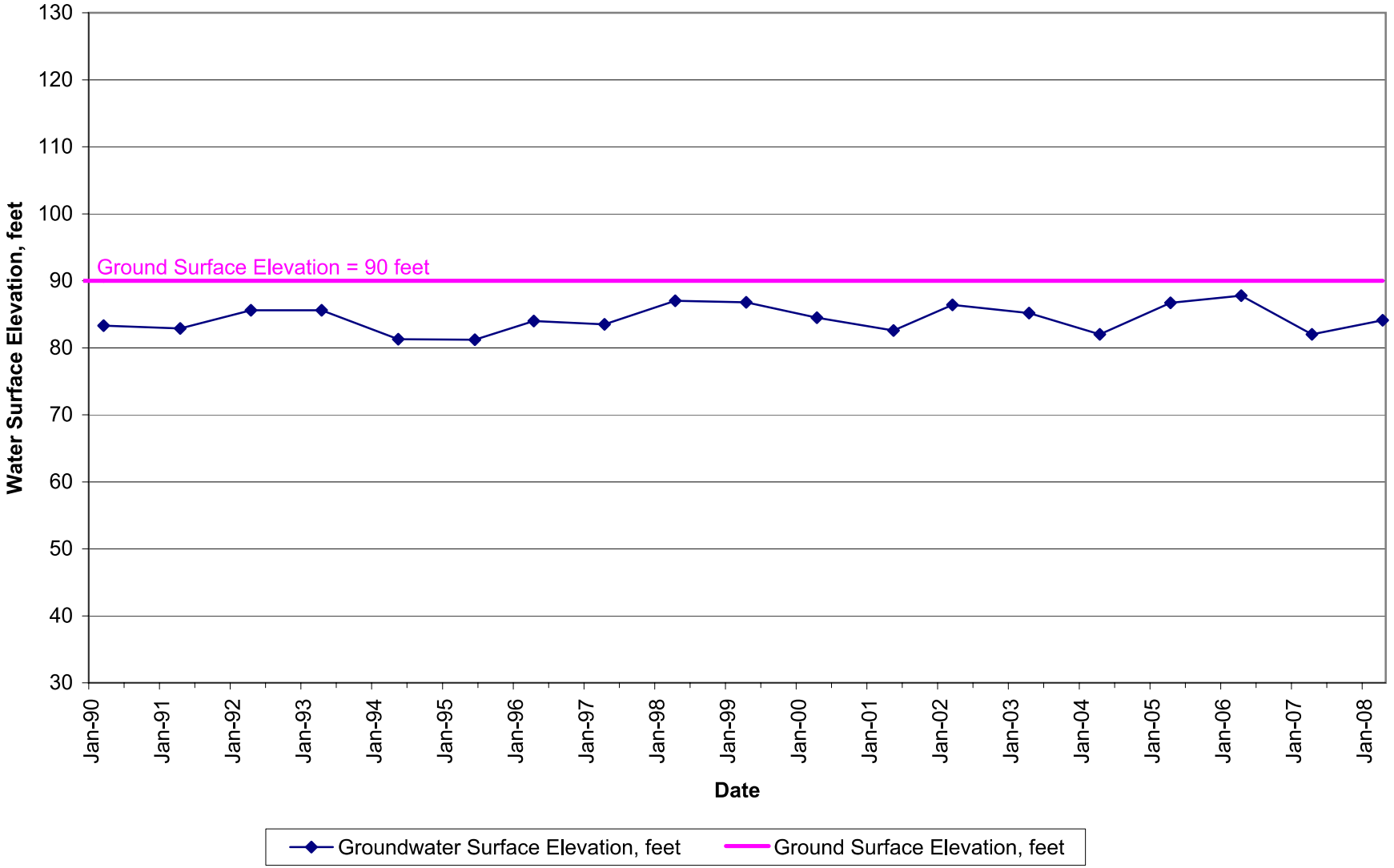

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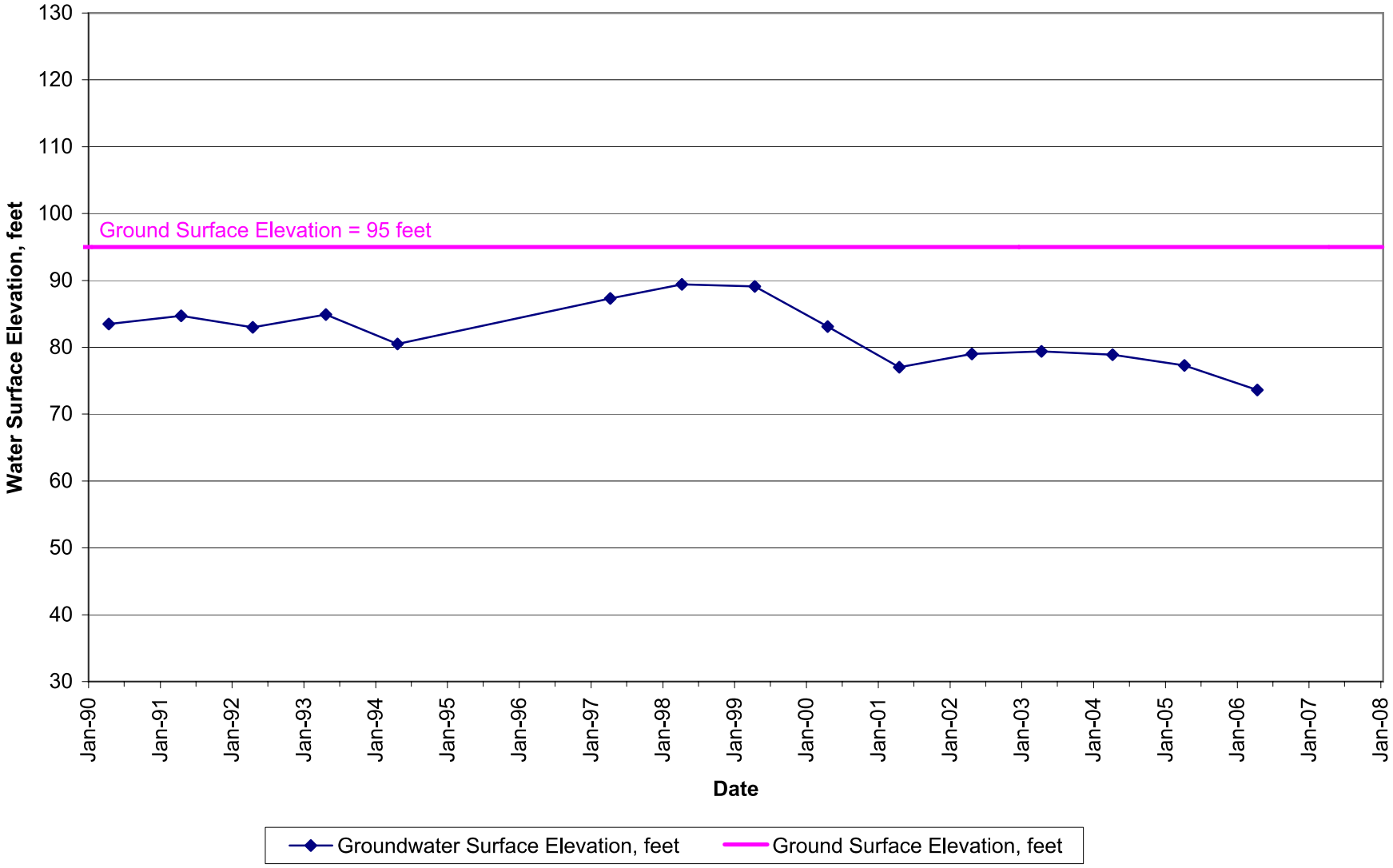

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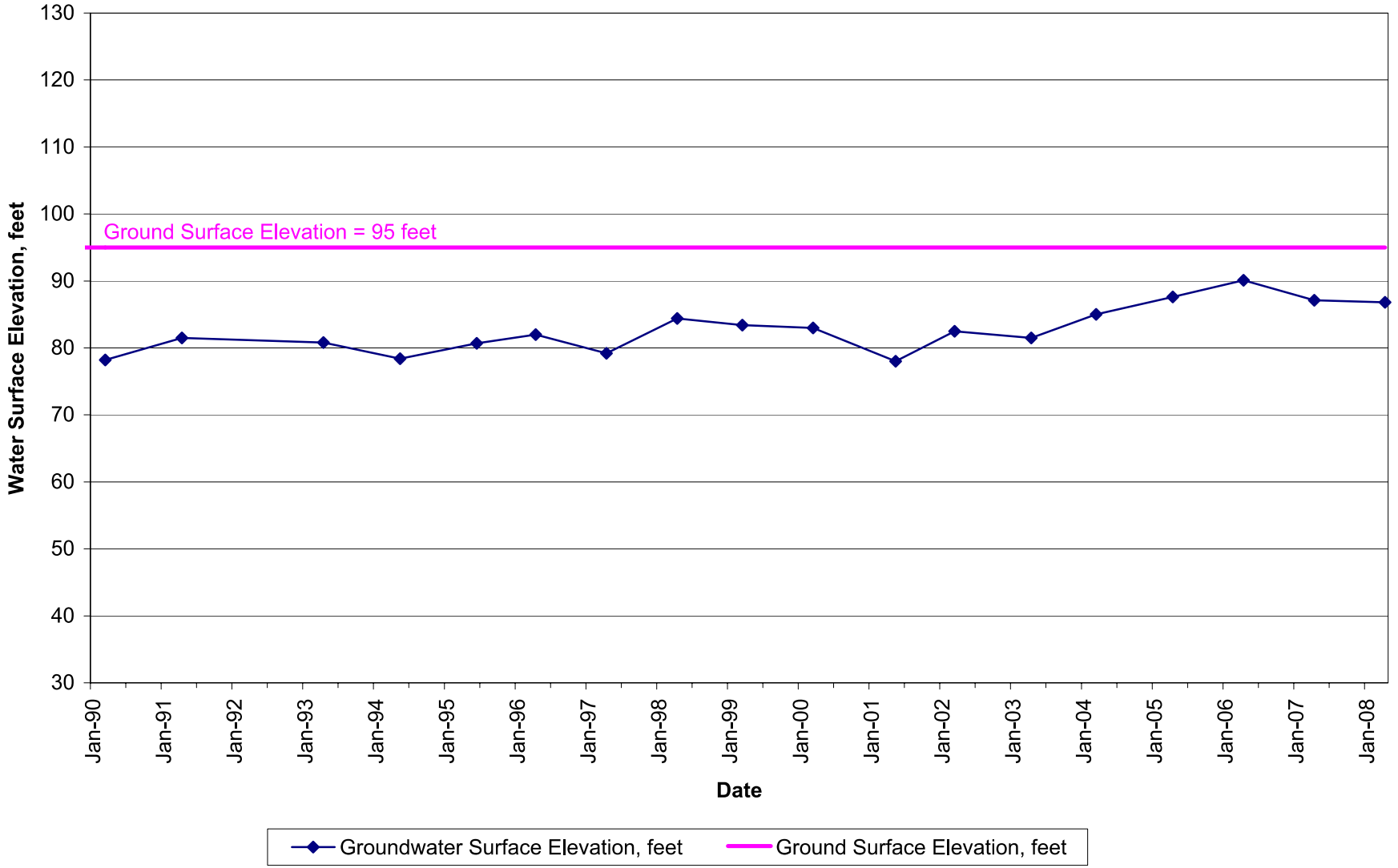

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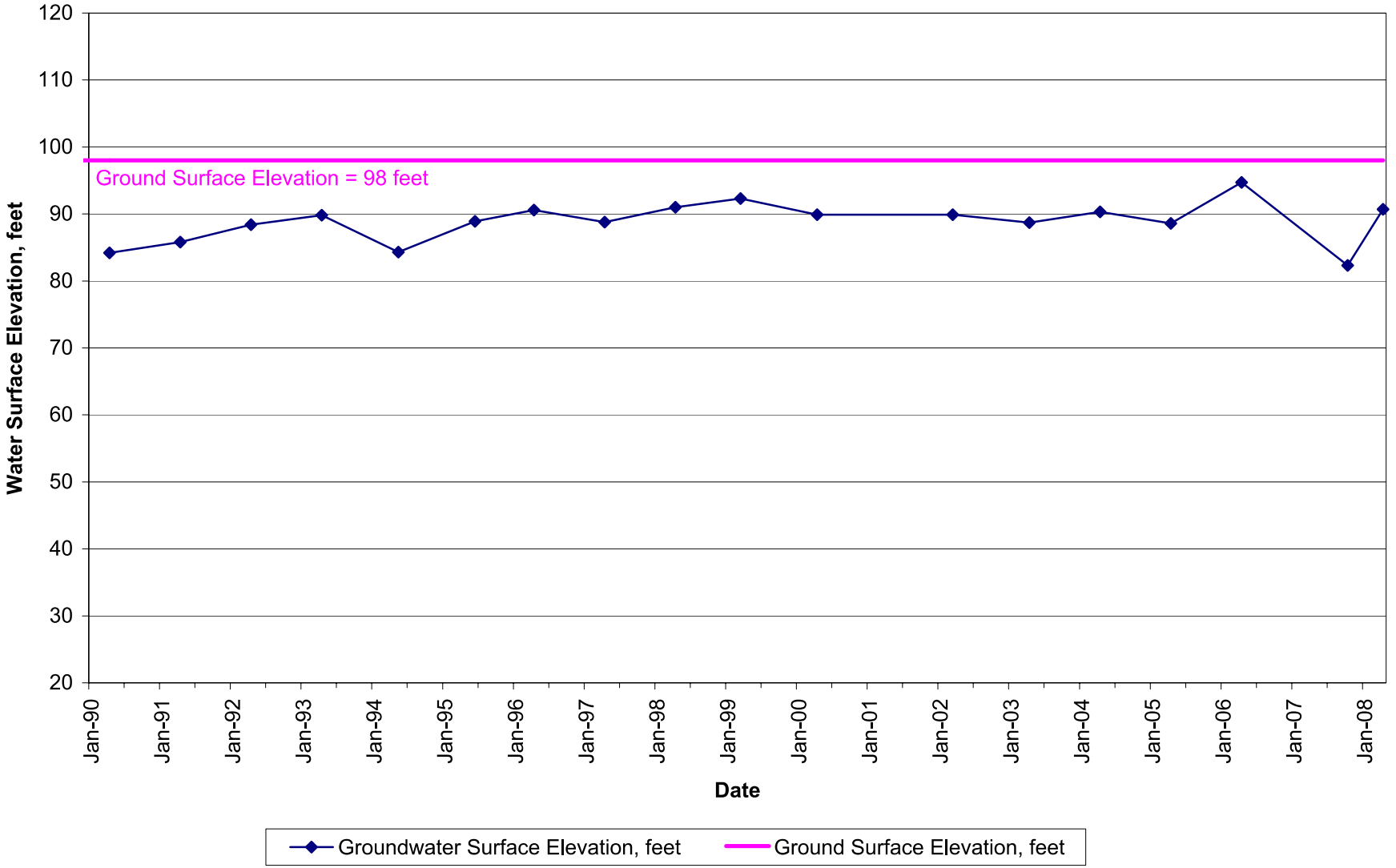

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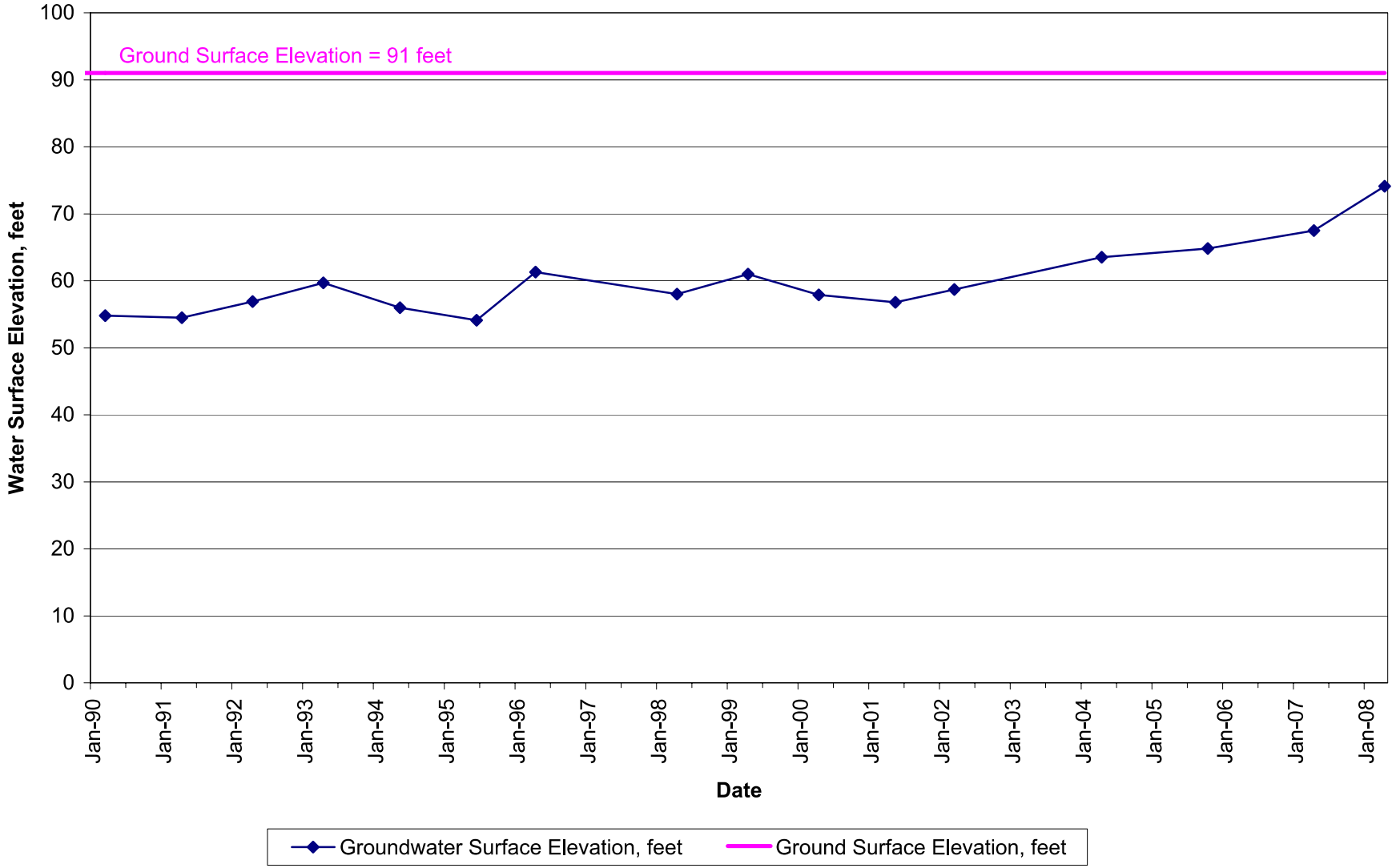

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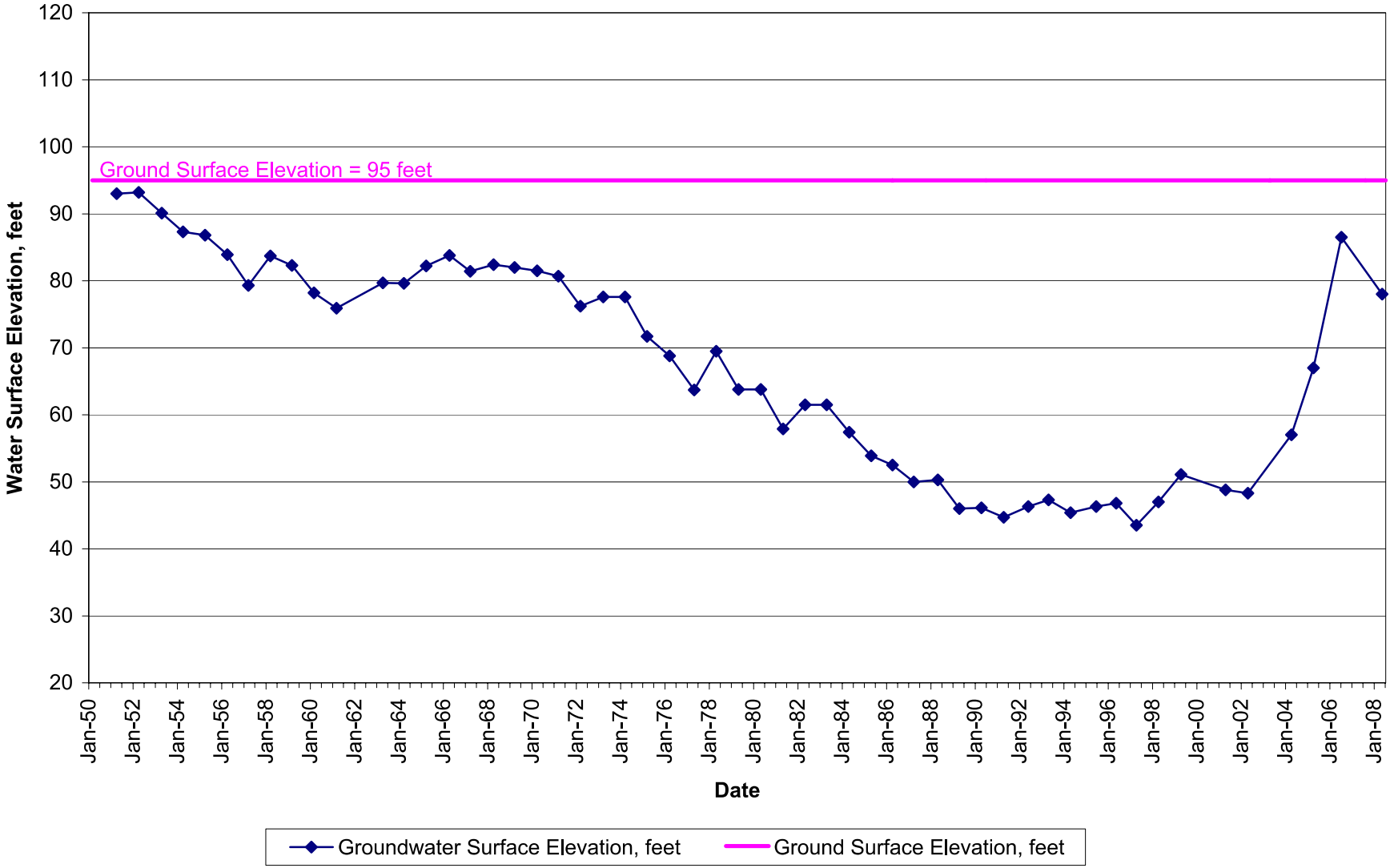

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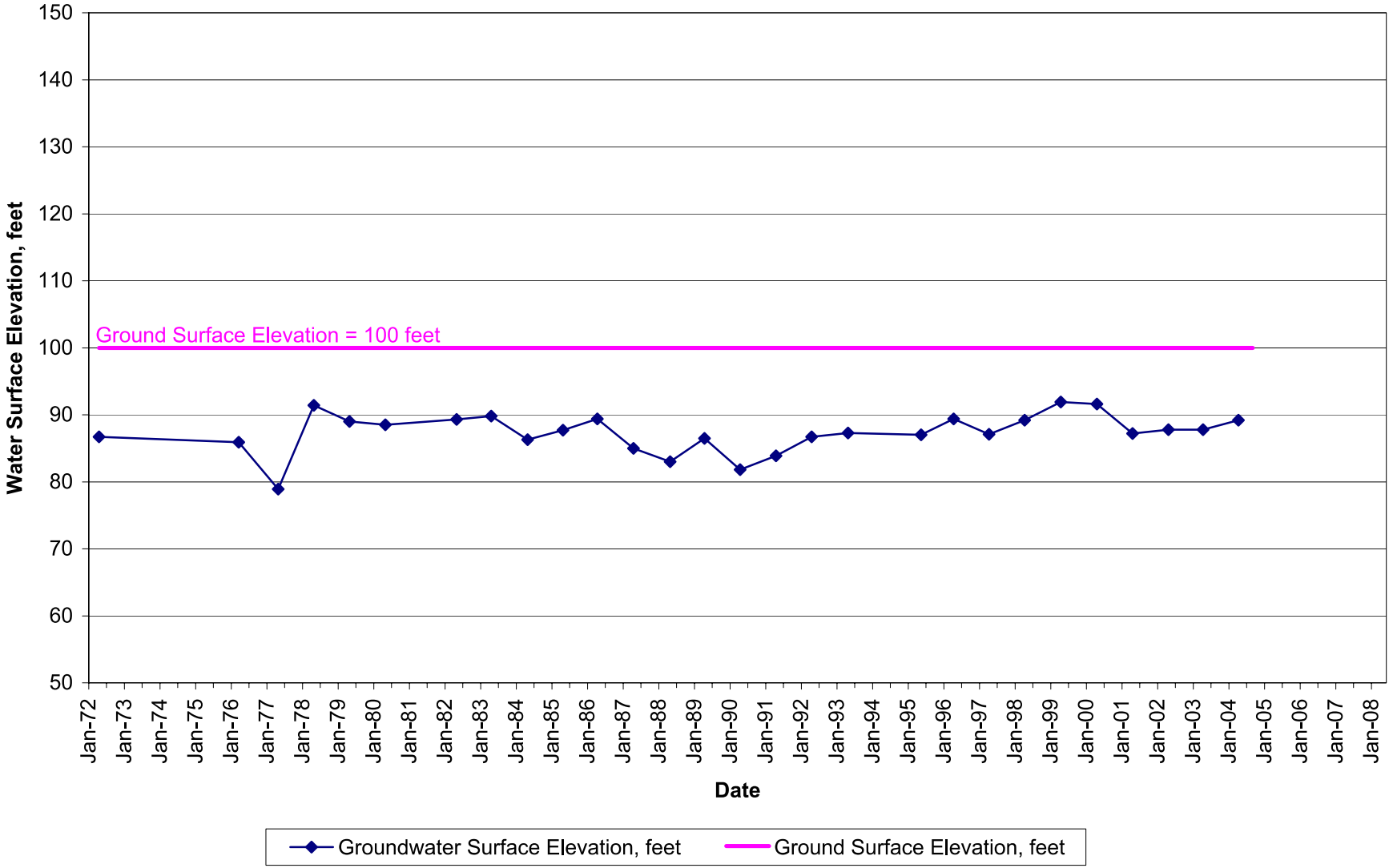

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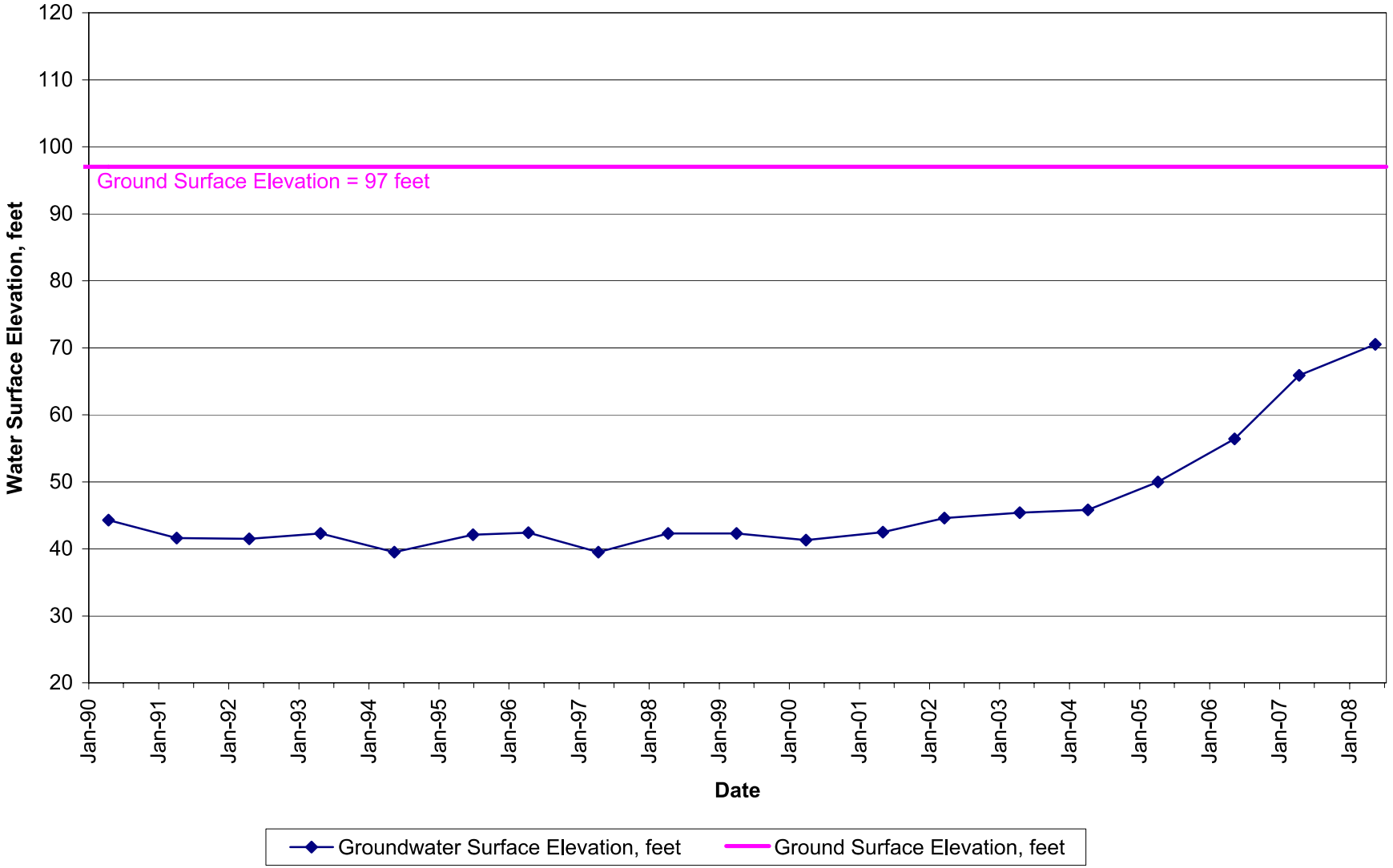

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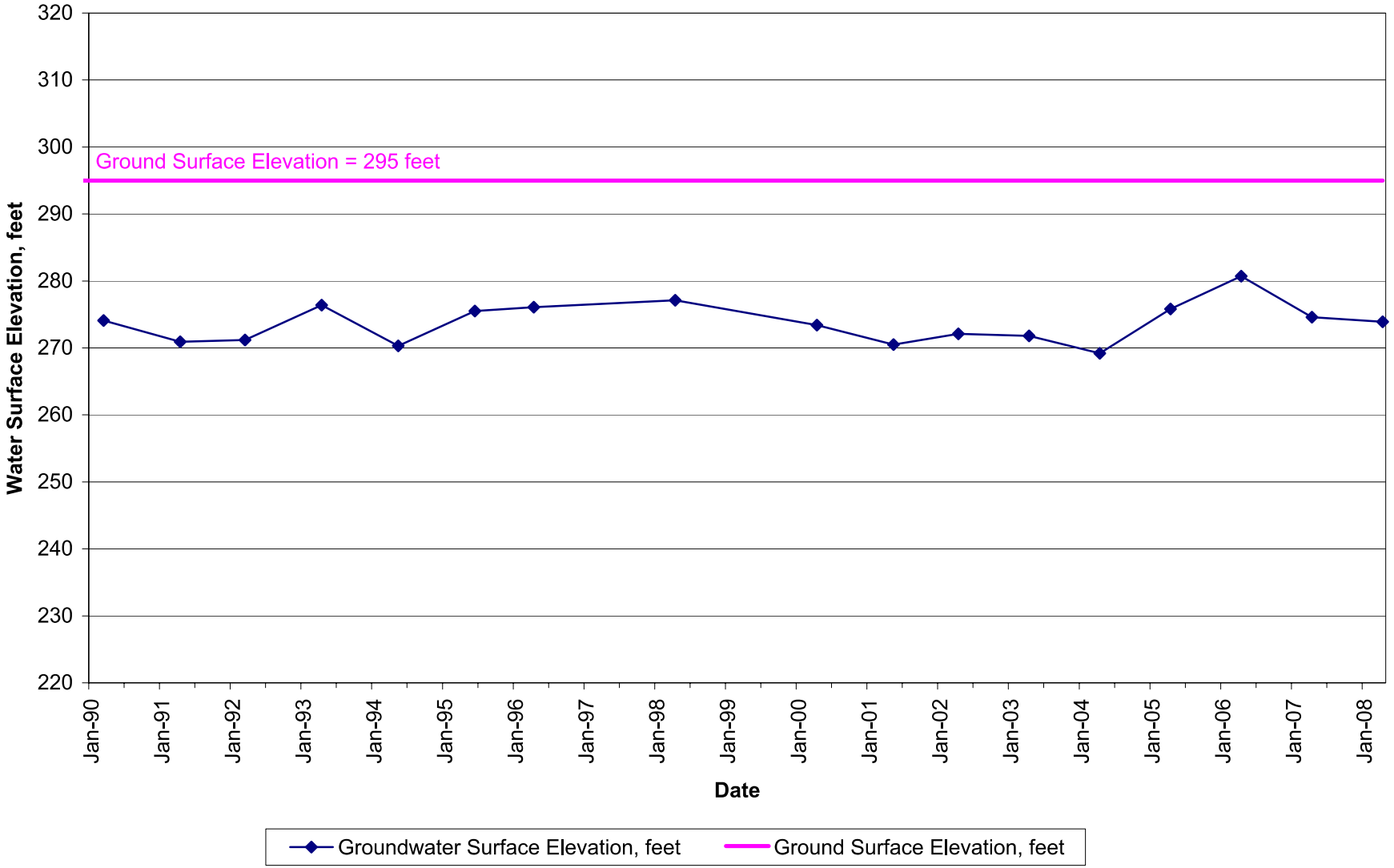
Rincon Valley Sub Basin



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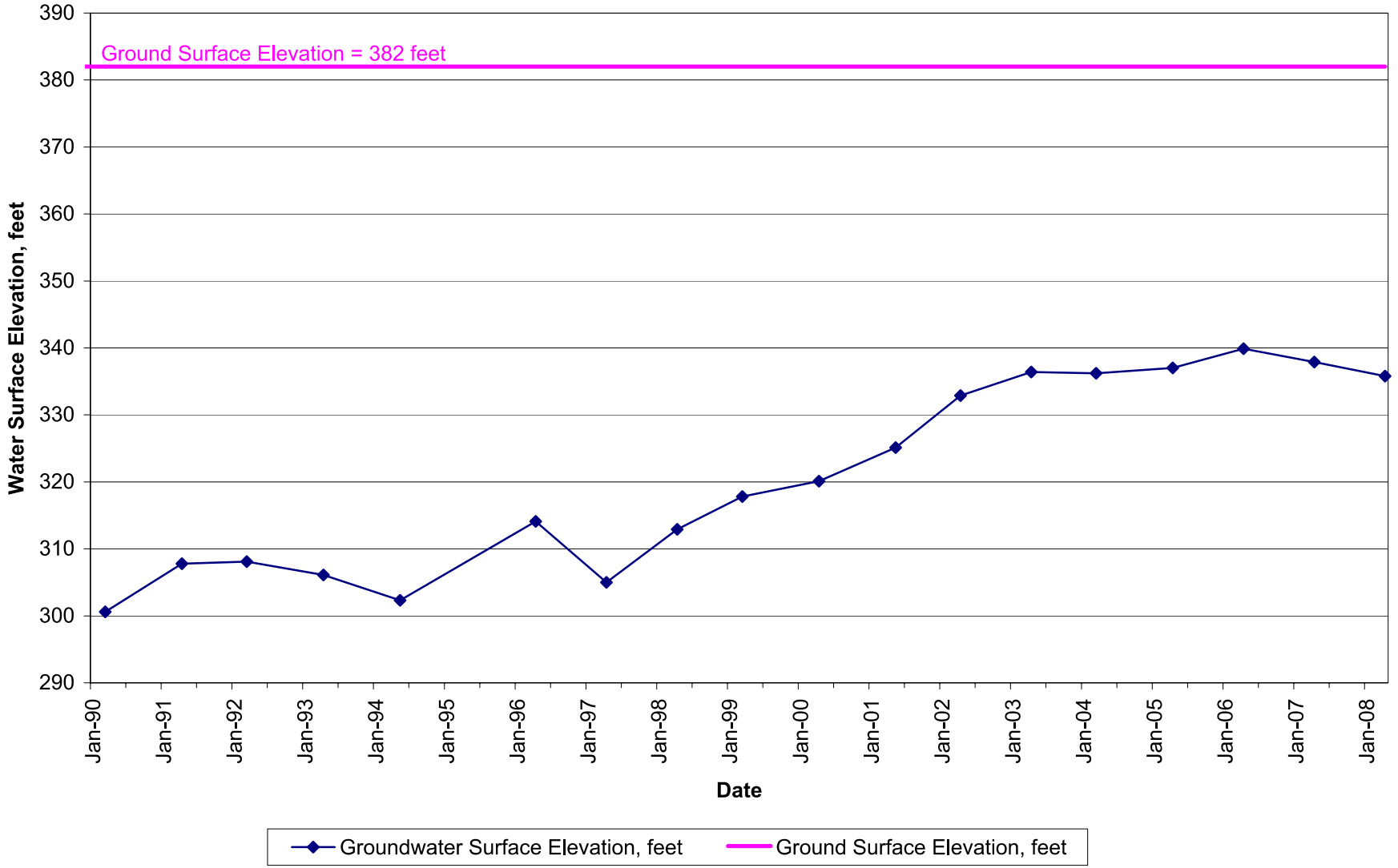
07N/07W-09P1 Historic Spring Groundwater Levels

Rincon Valley Sub Basin



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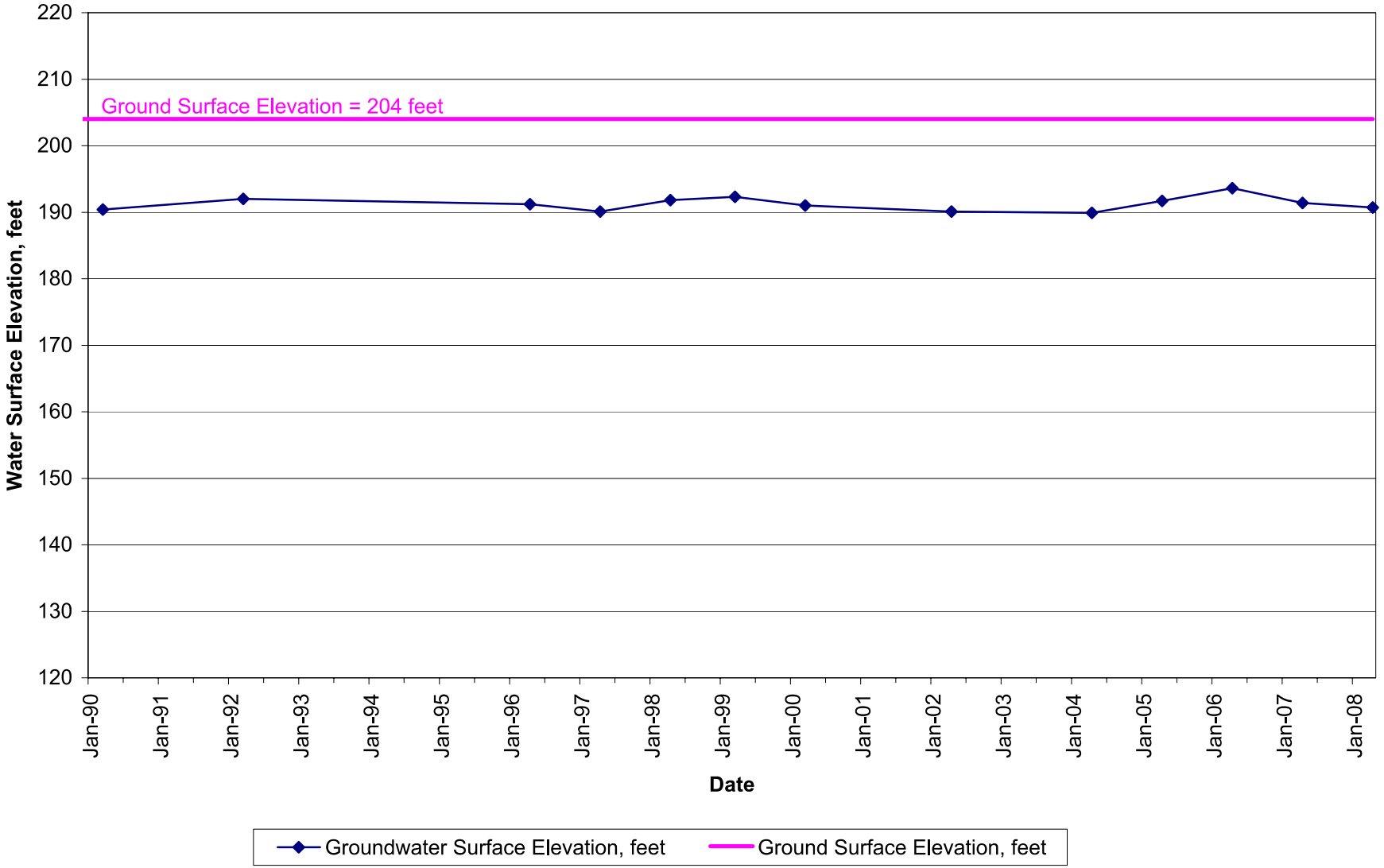
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/07W-19B1 Historic Spring Groundwater Levels



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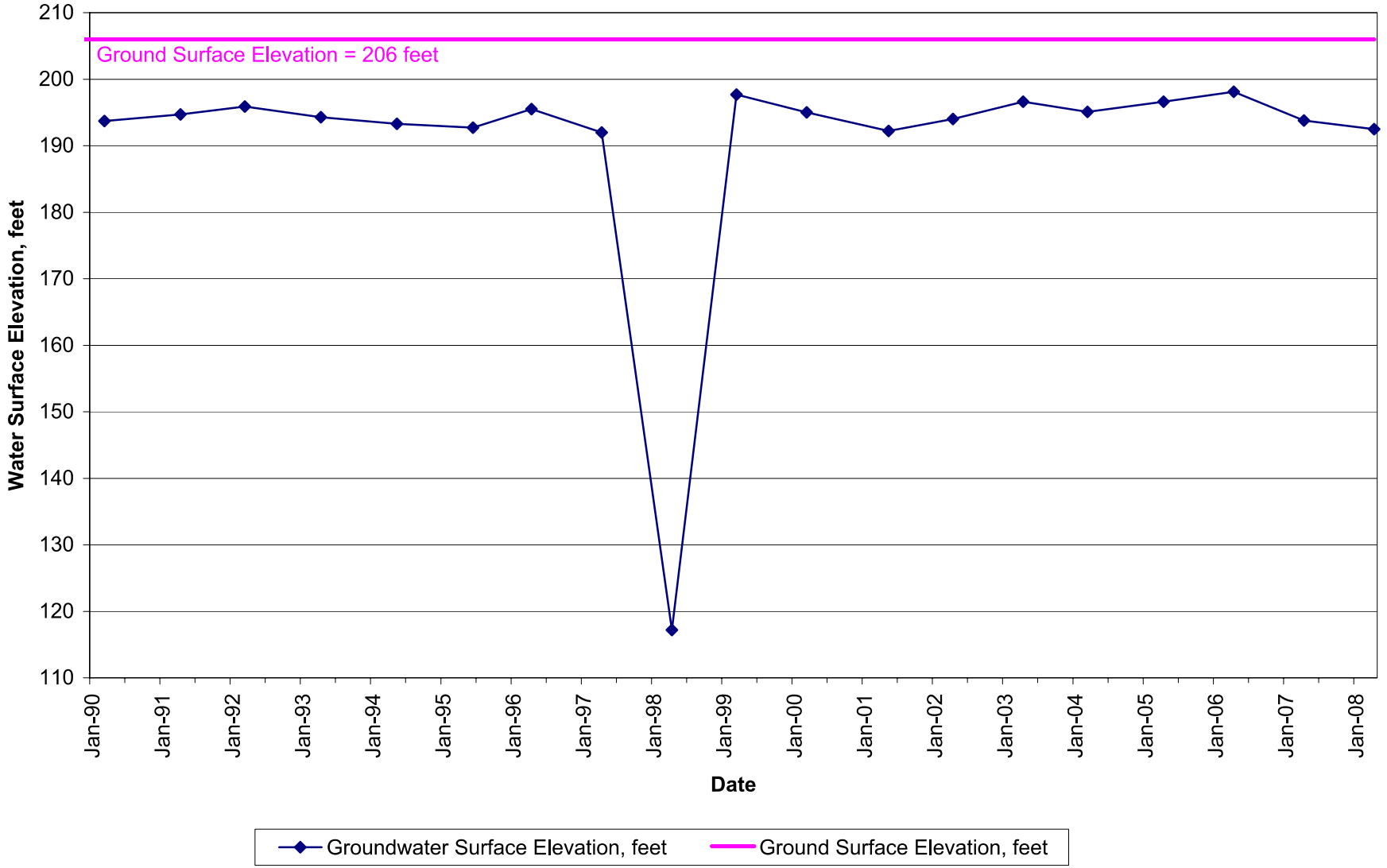
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/07W-19F2 Historic Spring Groundwater Levels



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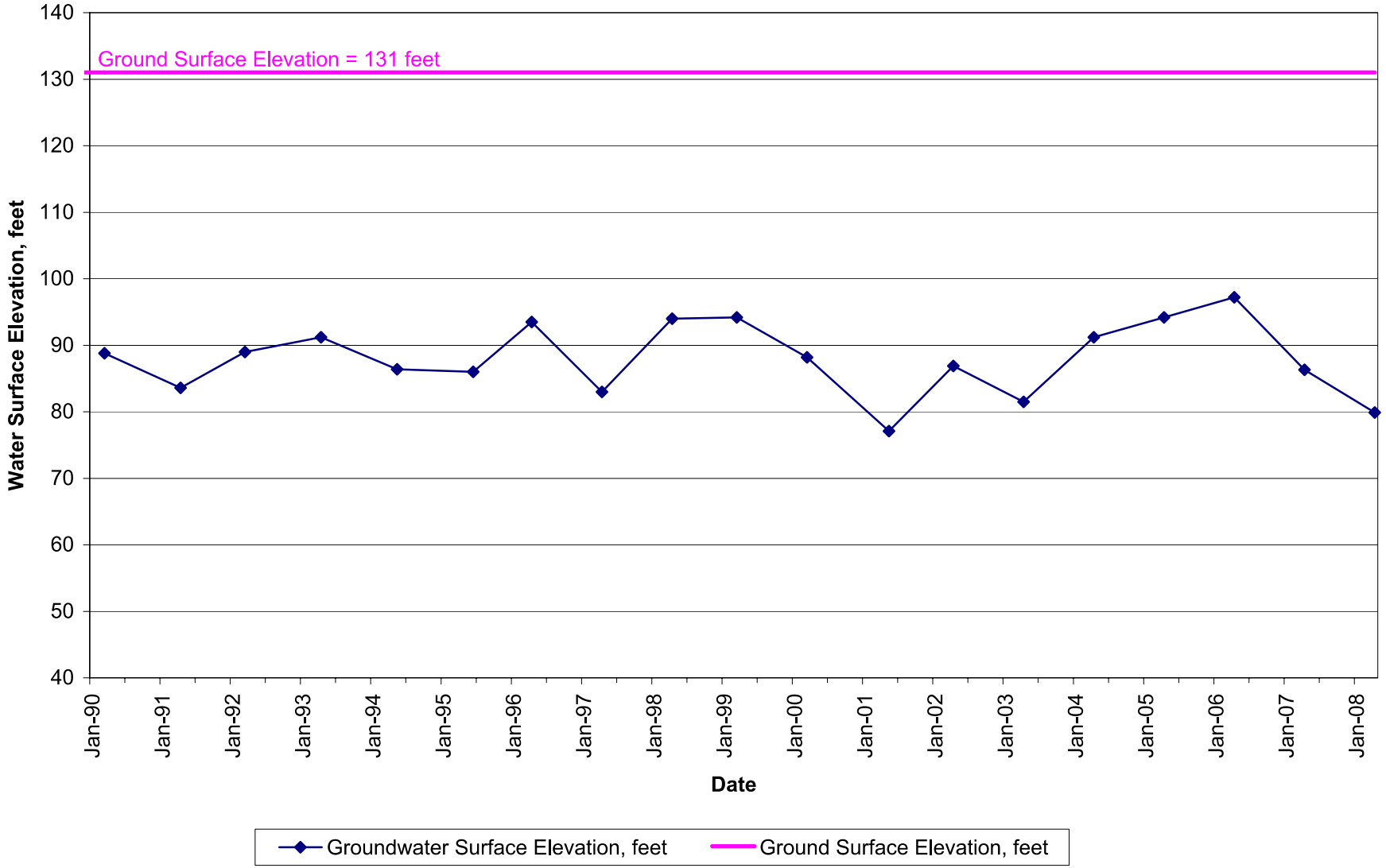
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/08W-08M1 Historic Spring Groundwater Levels



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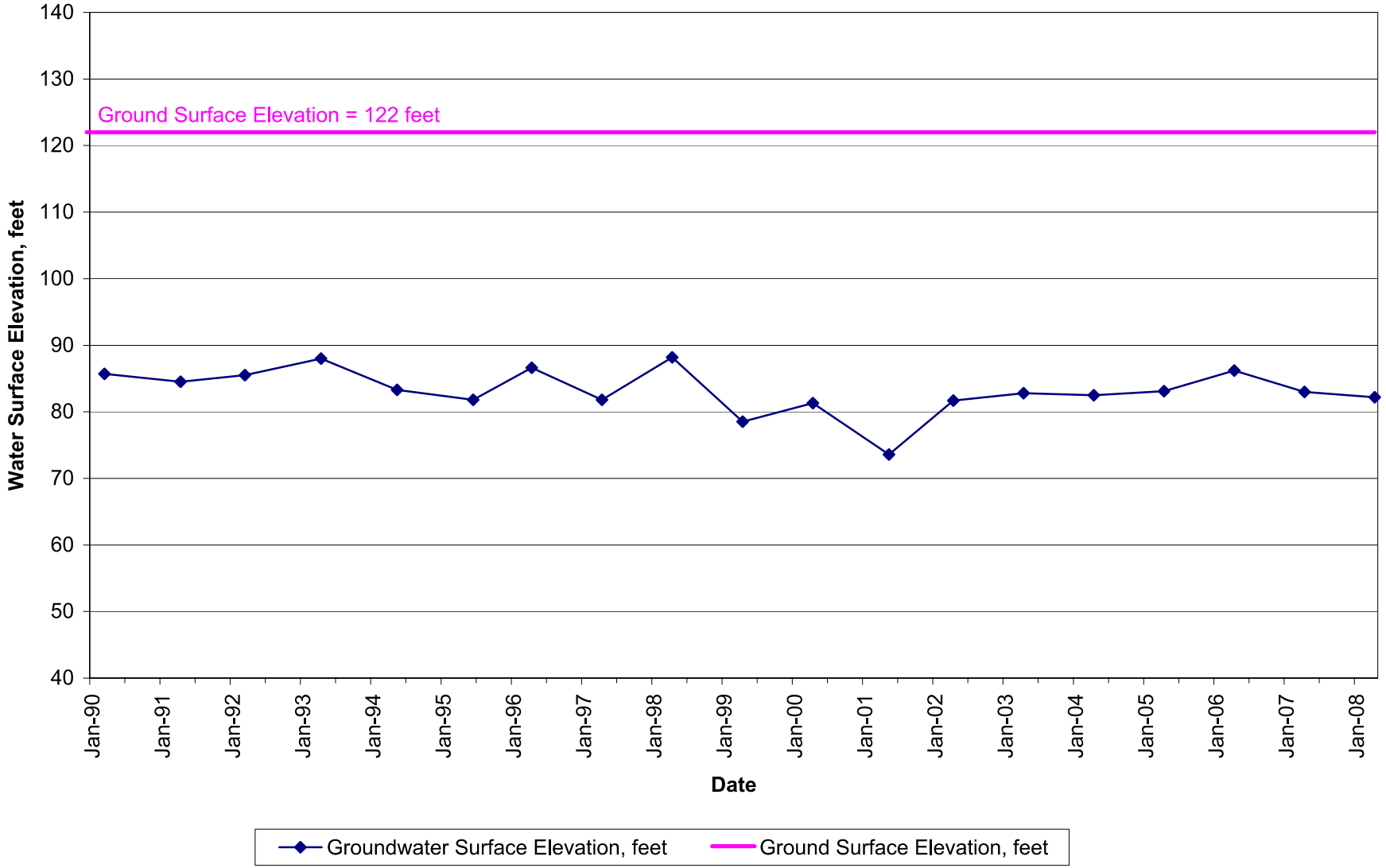
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/08W-21J1 Historic Spring Groundwater Levels

Well Depth = Shallow/Intermediate



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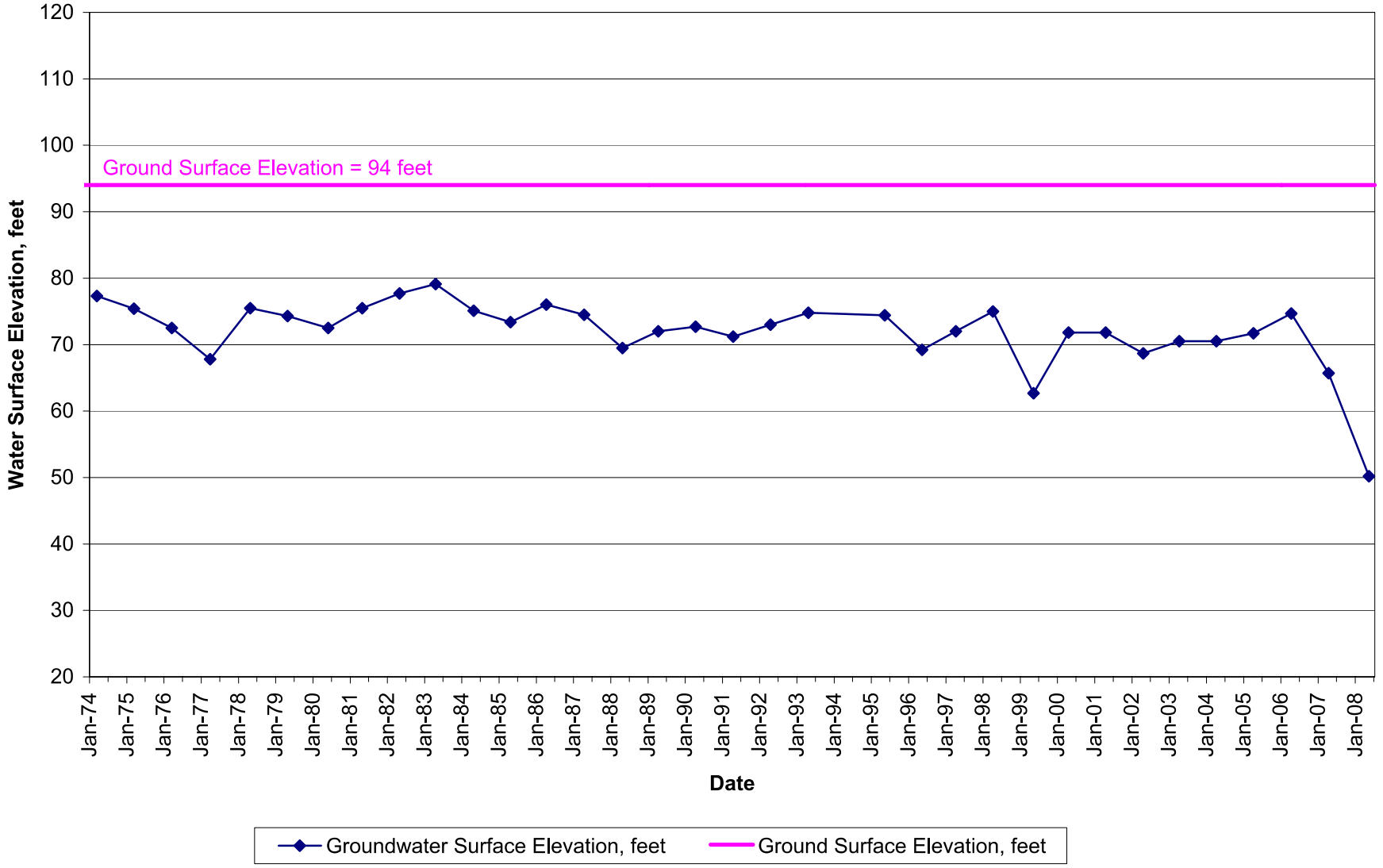
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/08W-30K1 Historic Spring Groundwater Levels

Well Depth = Shallow/Intermediate



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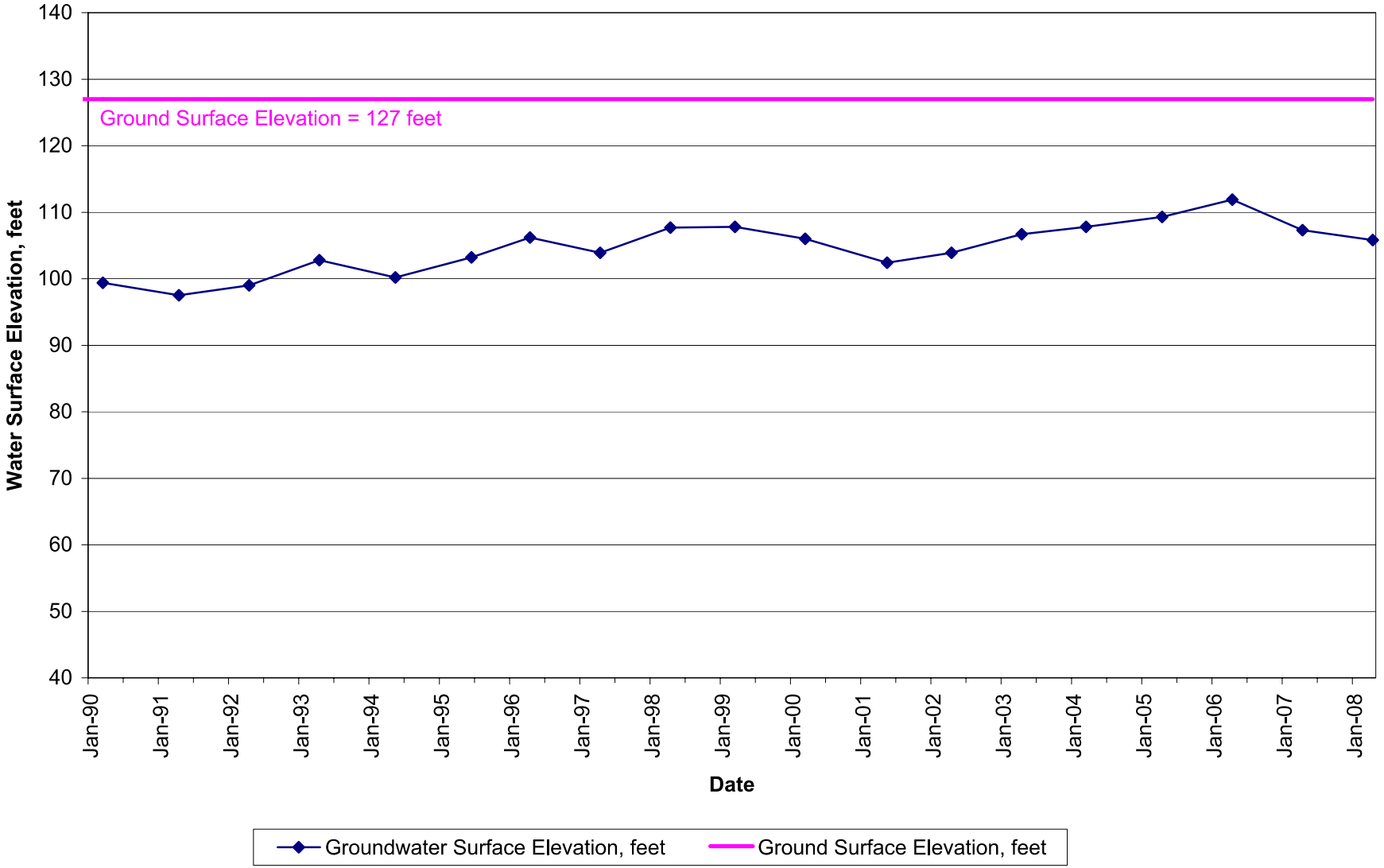
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/08W-35K1 Historic Spring Groundwater Levels



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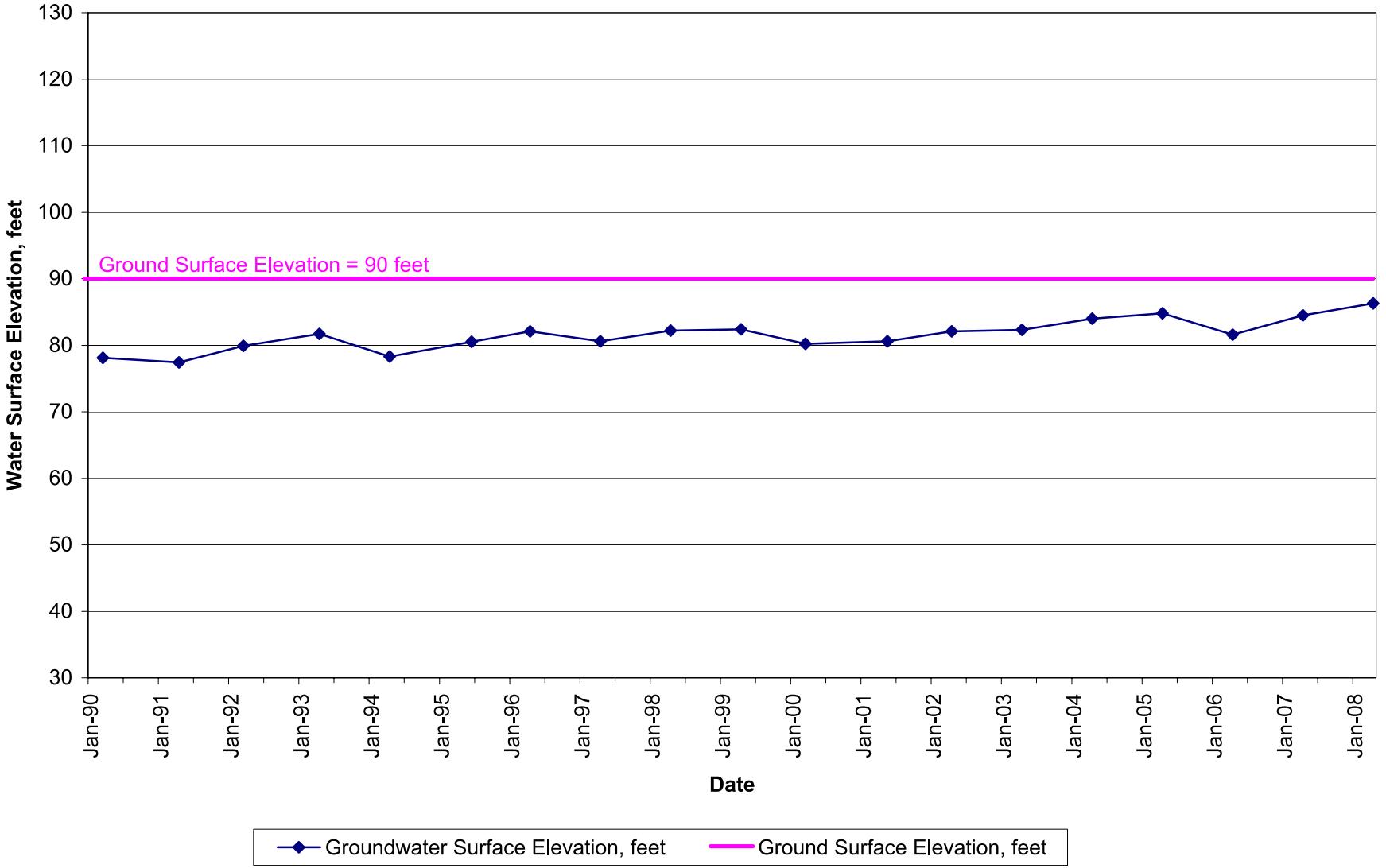
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/09W-01C1 Historic Spring Groundwater Levels



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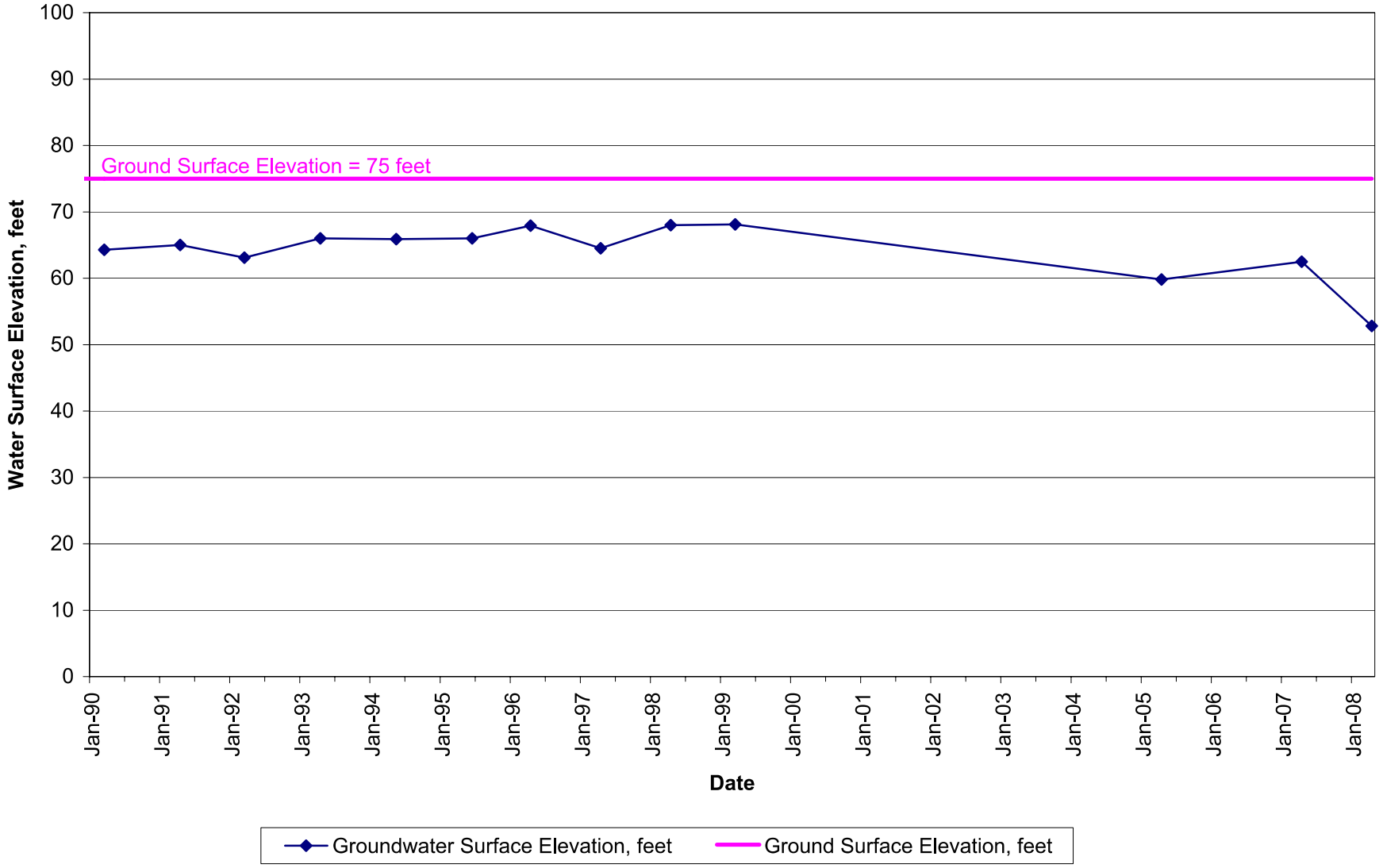
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/09W-15K1 Historic Spring Groundwater Levels



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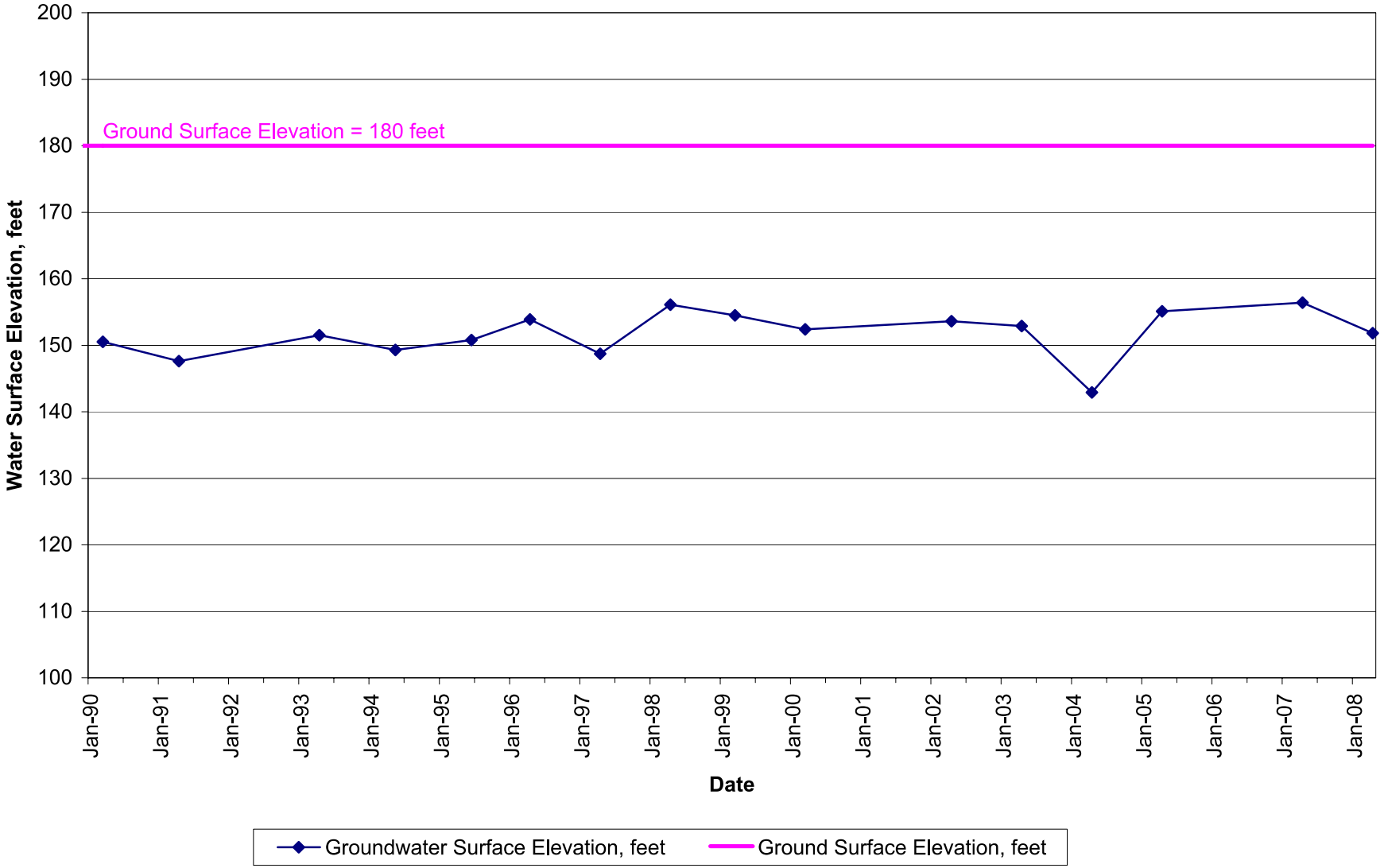
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/09W-16M1 Historic Spring Groundwater Levels



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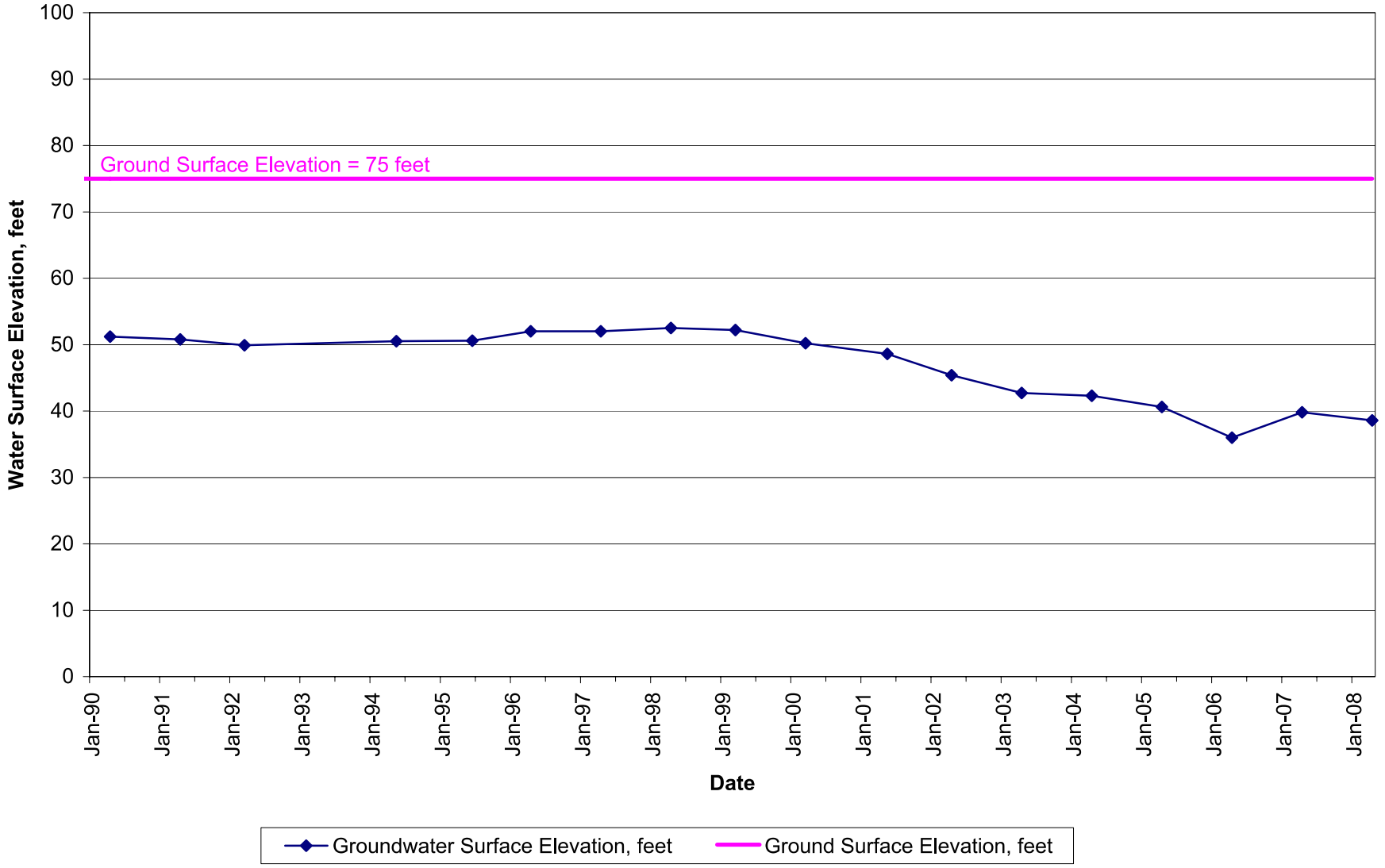
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/09W-26P1 Historic Spring Groundwater Levels



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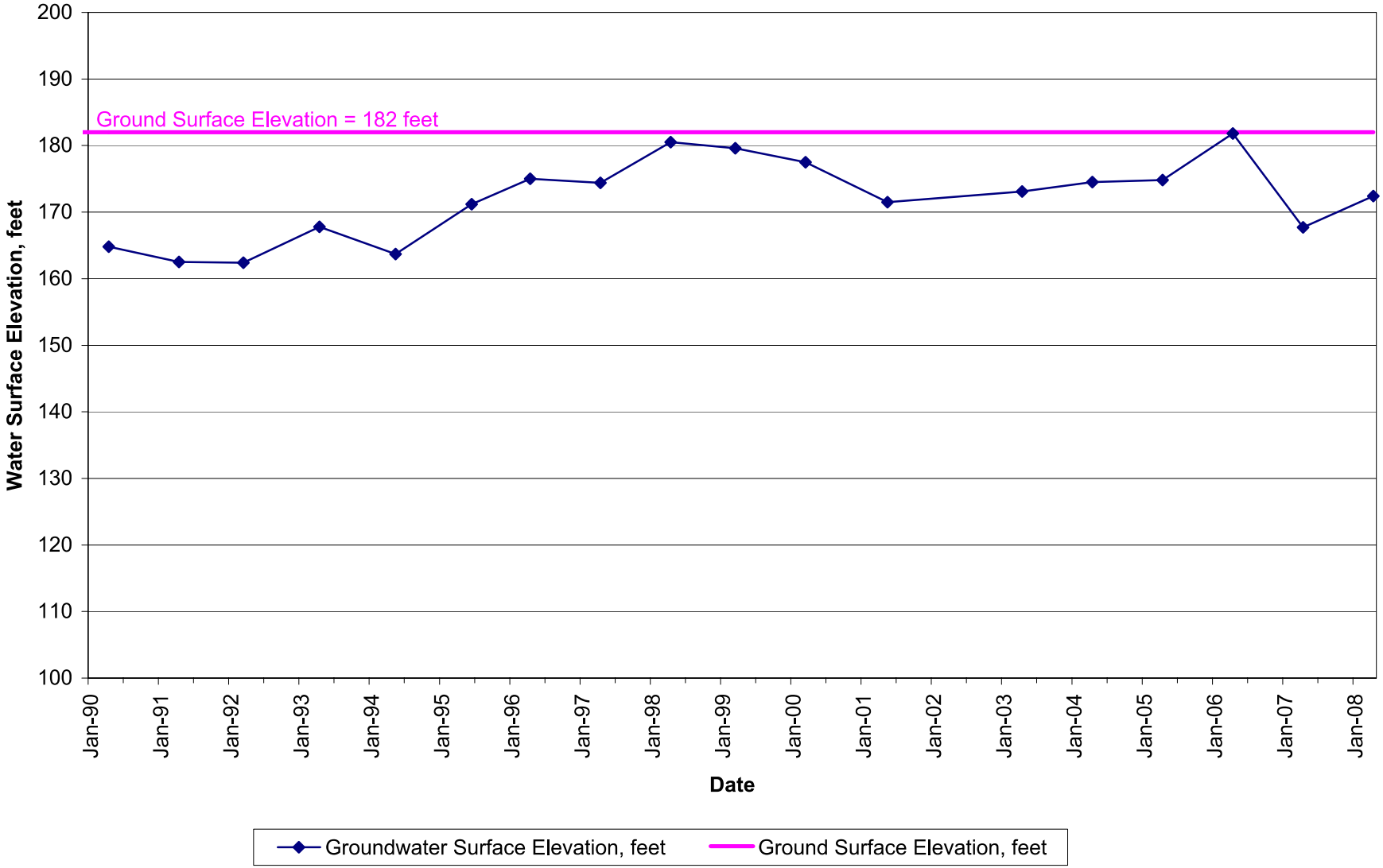
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/09W-34F1 Historic Spring Groundwater Levels

Well Depth = Shallow



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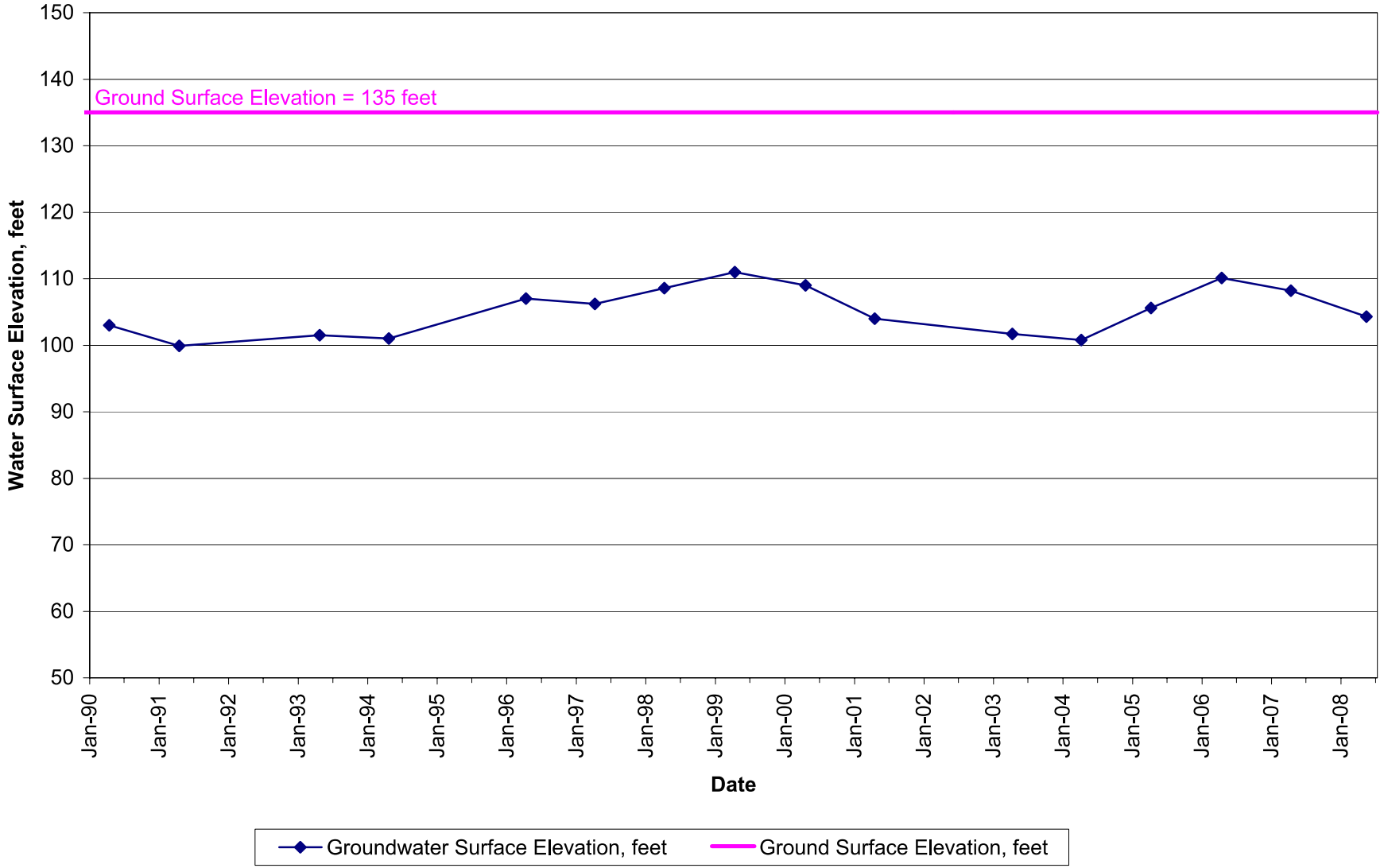
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

07N/09W-35D2 Historic Spring Groundwater Levels



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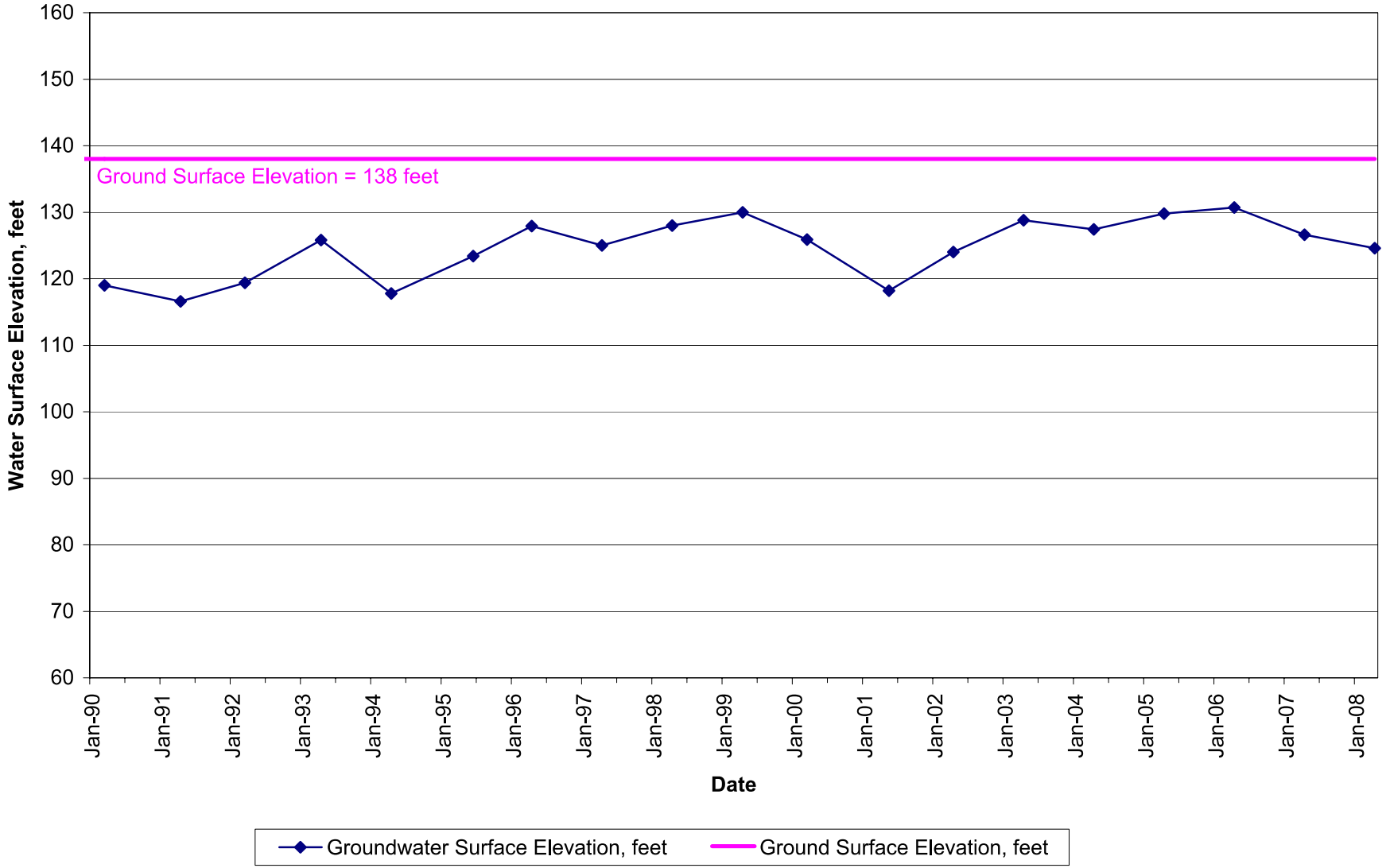
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

08N/08W-29B1 Historic Spring Groundwater Levels



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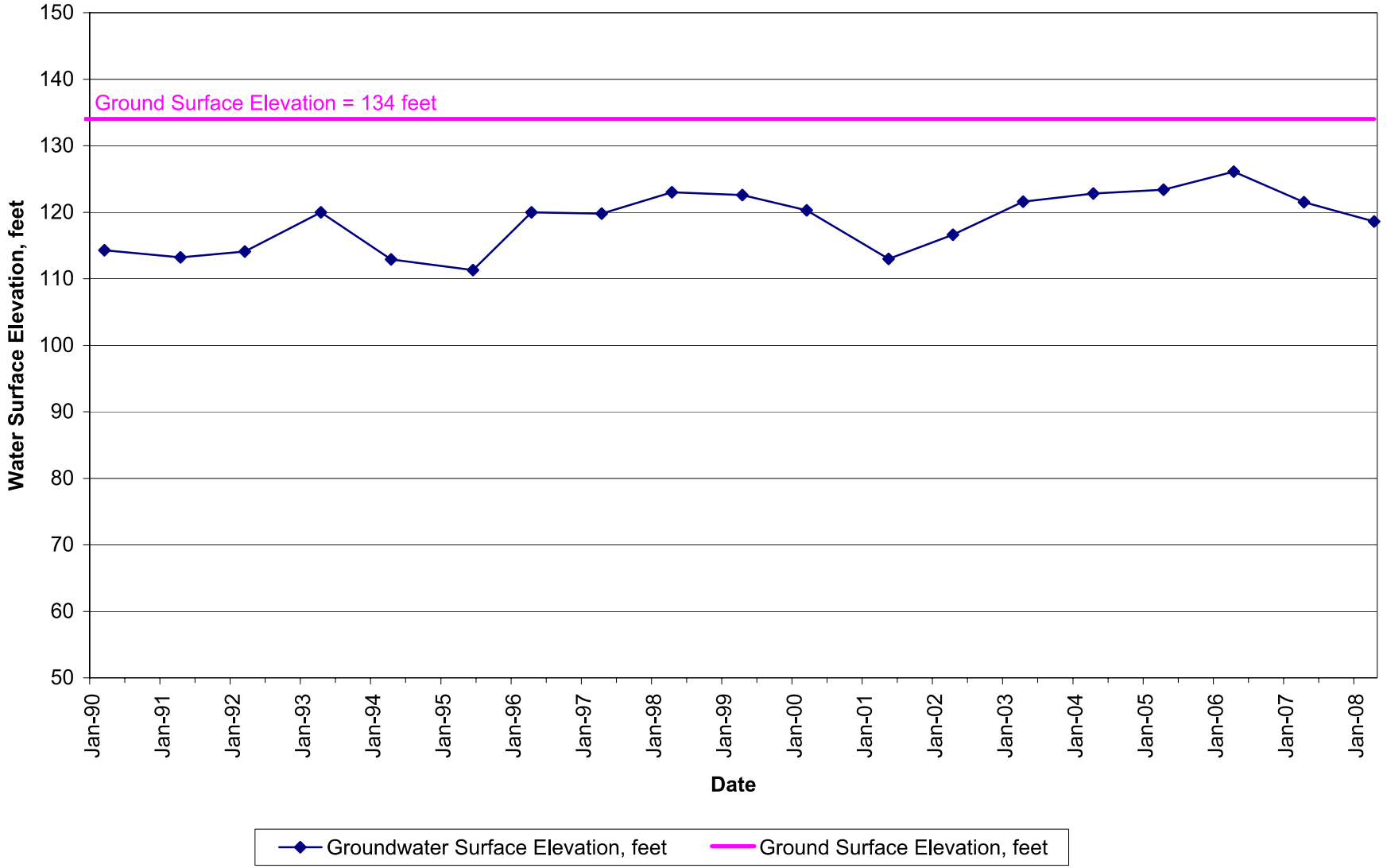
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

08N/08W-29C3 Historic Spring Groundwater Levels



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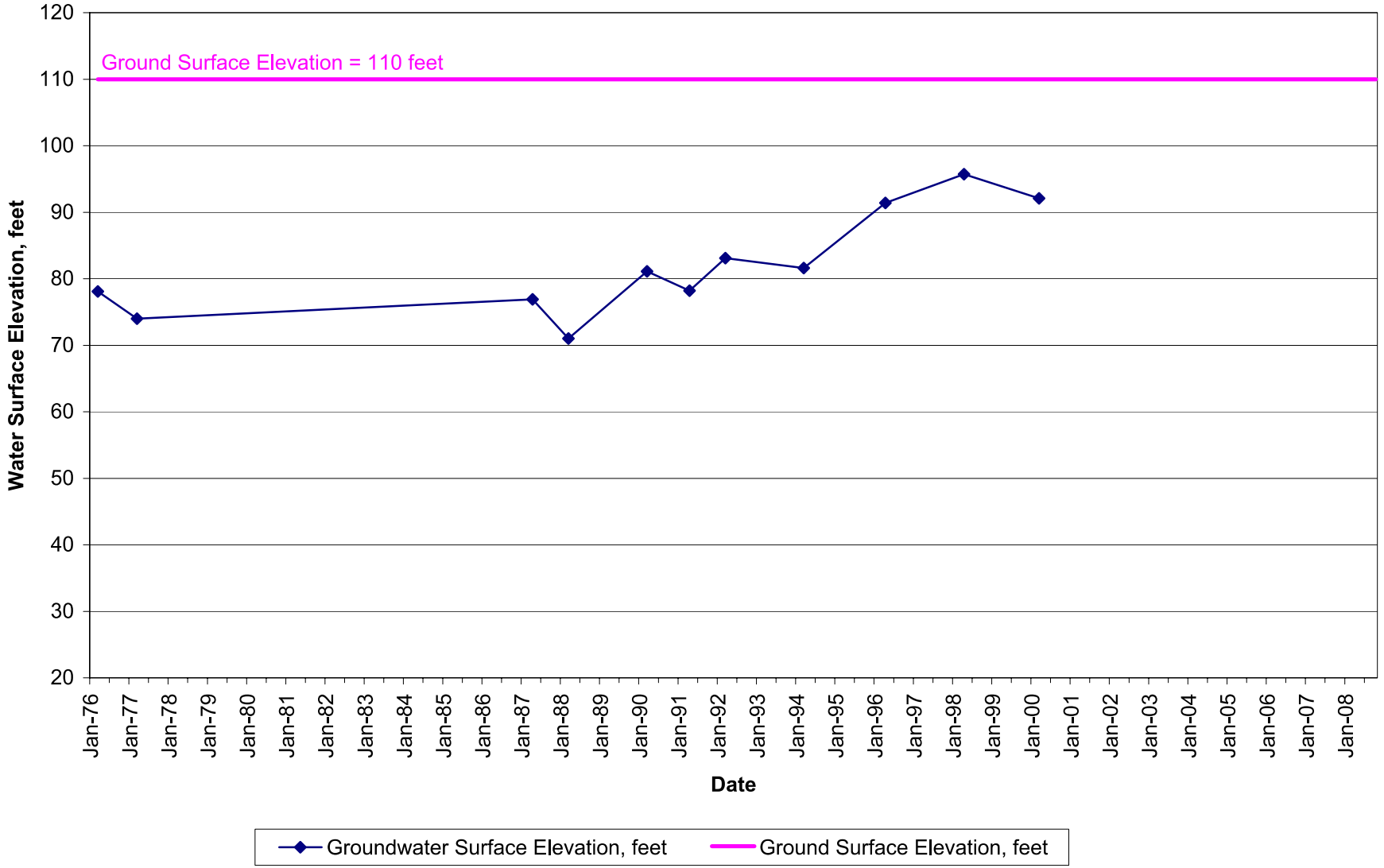
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

08N/09W-12P1 Historic Spring Groundwater Levels



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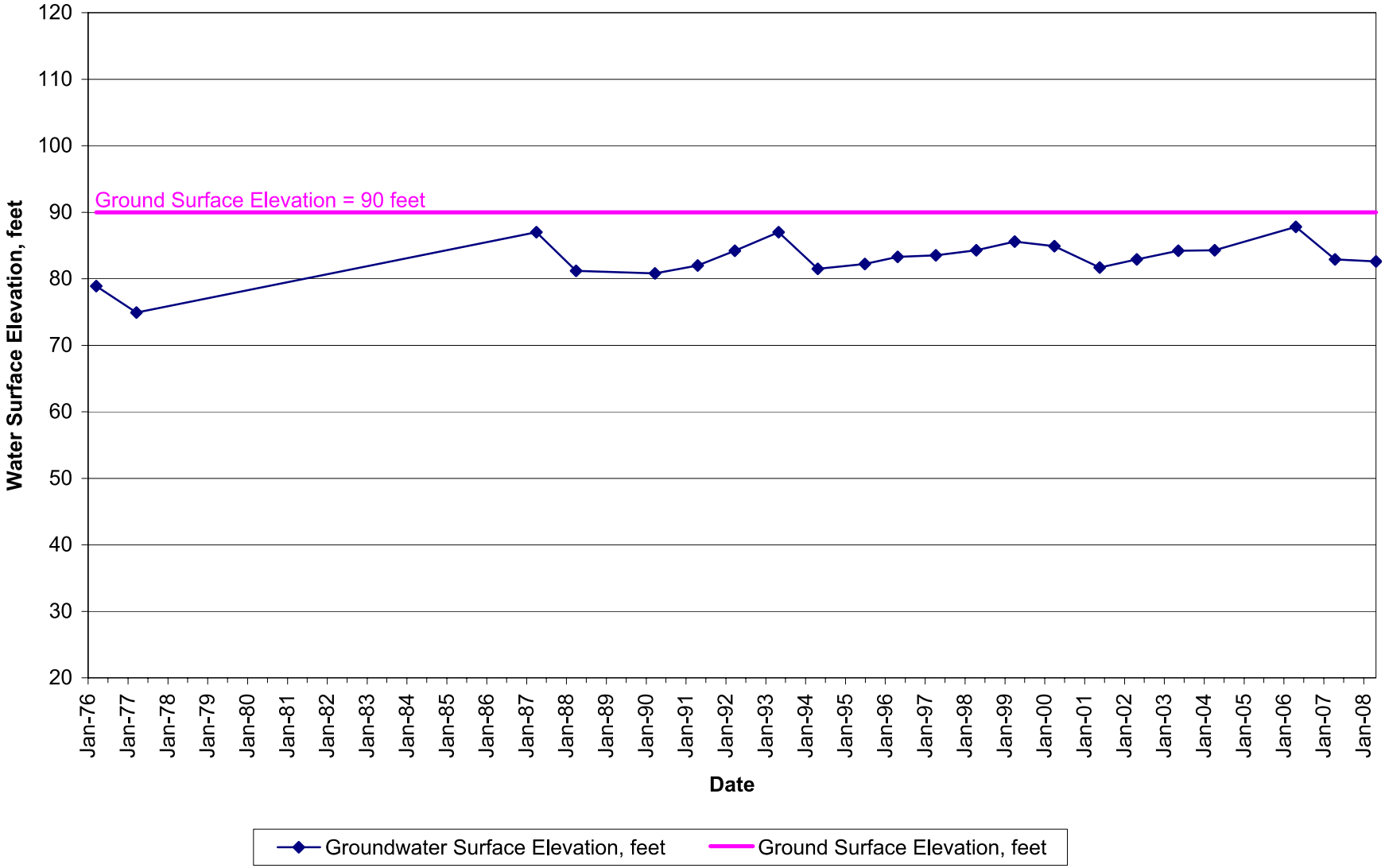
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

08N/09W-36N1 Historic Spring Groundwater Levels



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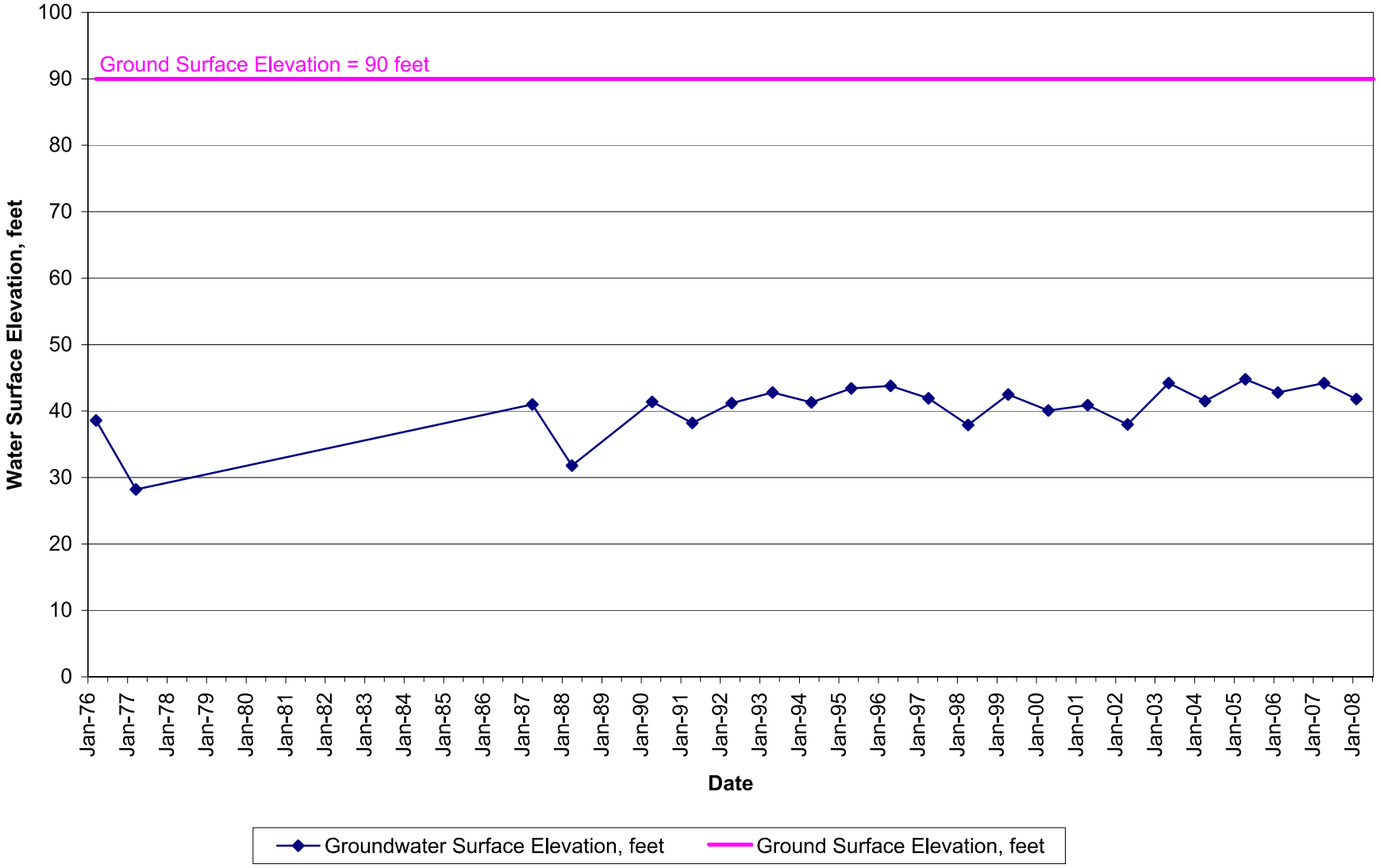
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

08N/09W-36P1 Historic Spring Groundwater Levels

Well Depth = 1,048 feet



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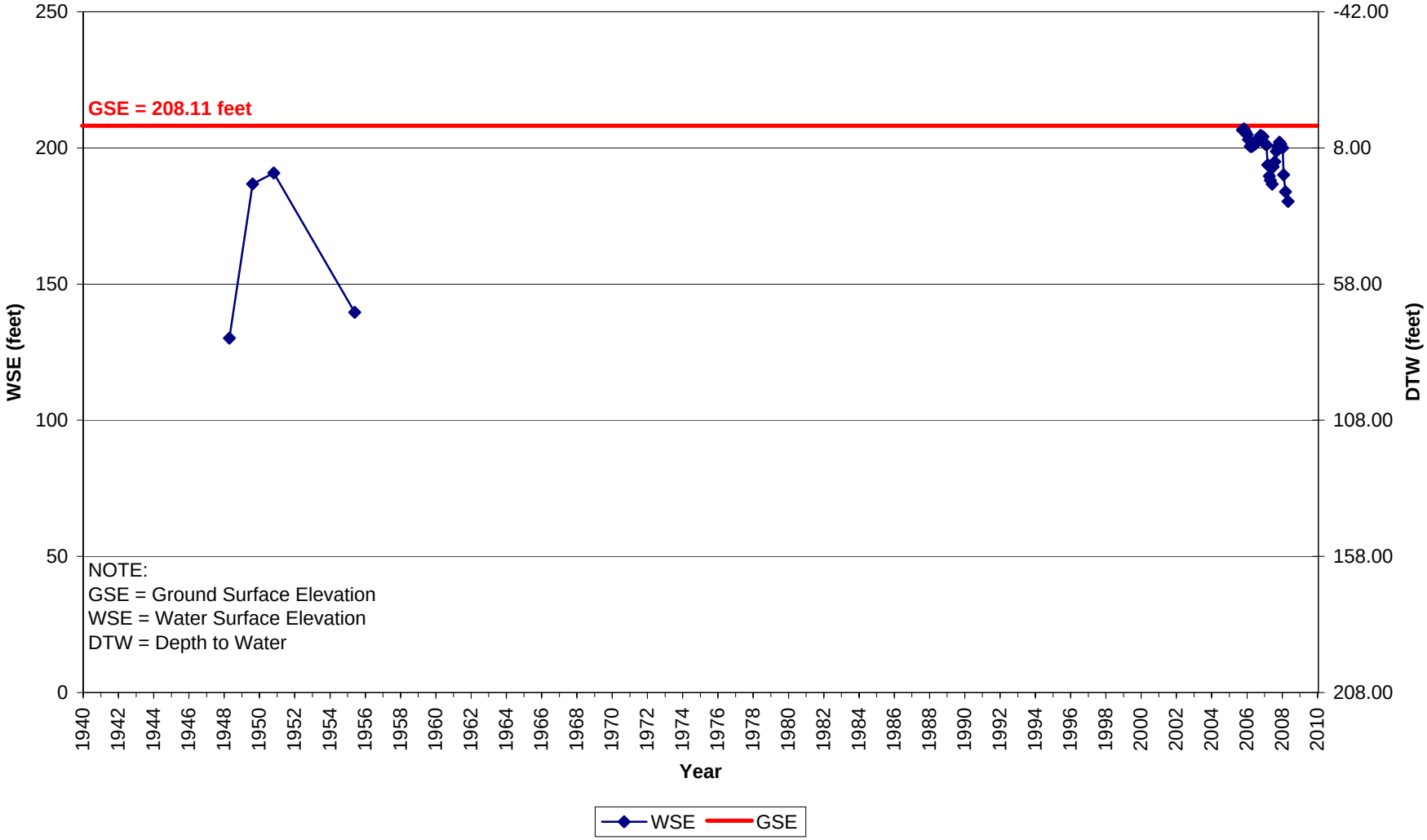
Spring GW Levels
Last Revised: August 20, 2008

West Yost Associates

Appendix B

City of Santa Rosa Well Hydrographs

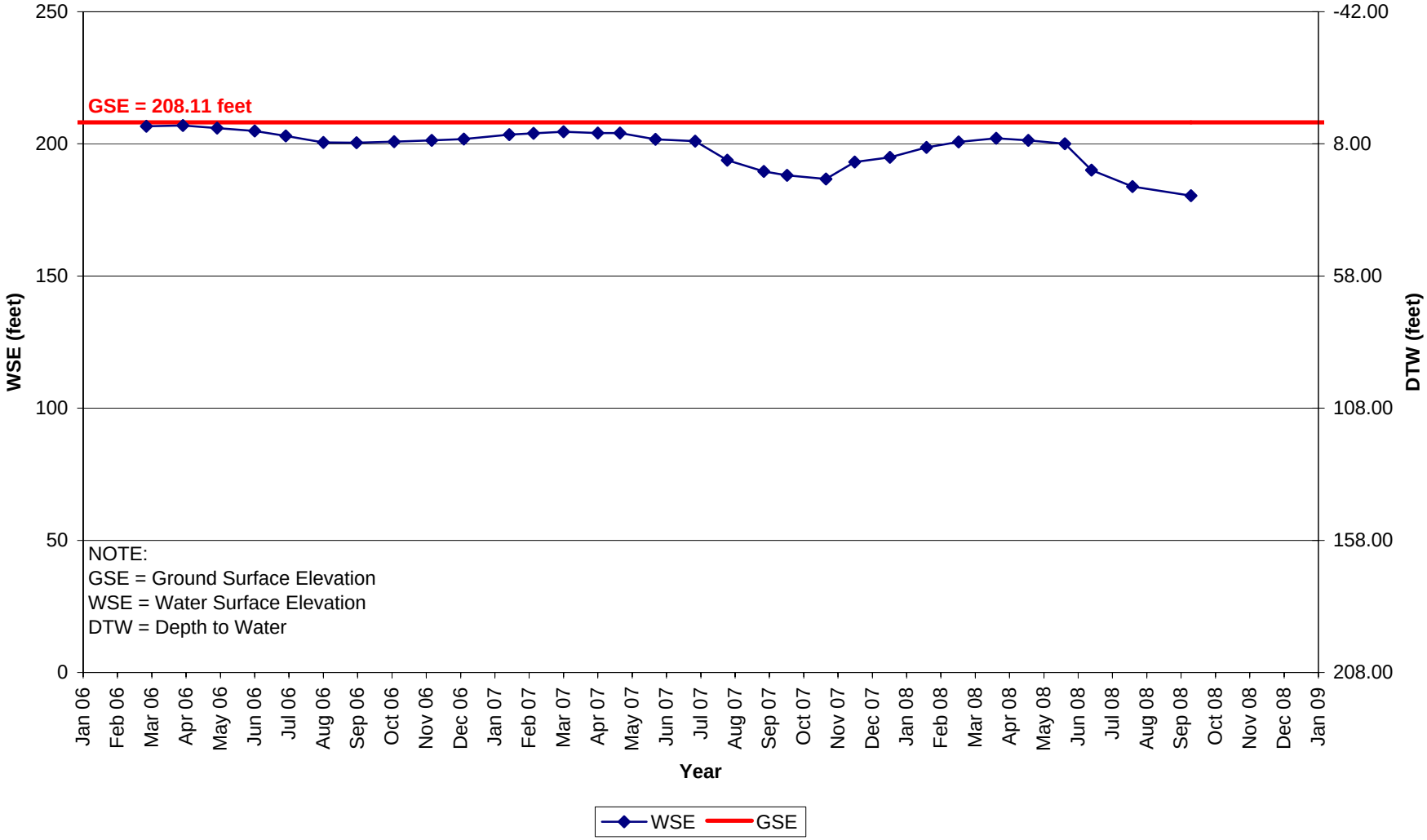
City of Santa Rosa: Groundwater Level Monitoring
Carley Well [4910009-001]
State Well No: T7N/R7W-18R2



Last Revised: 09/10/2008
O:\C\405\02-06-19\E\GW Monitoring\SR_WaterLevel.xls [C_CARLEY]

West Yost Associates

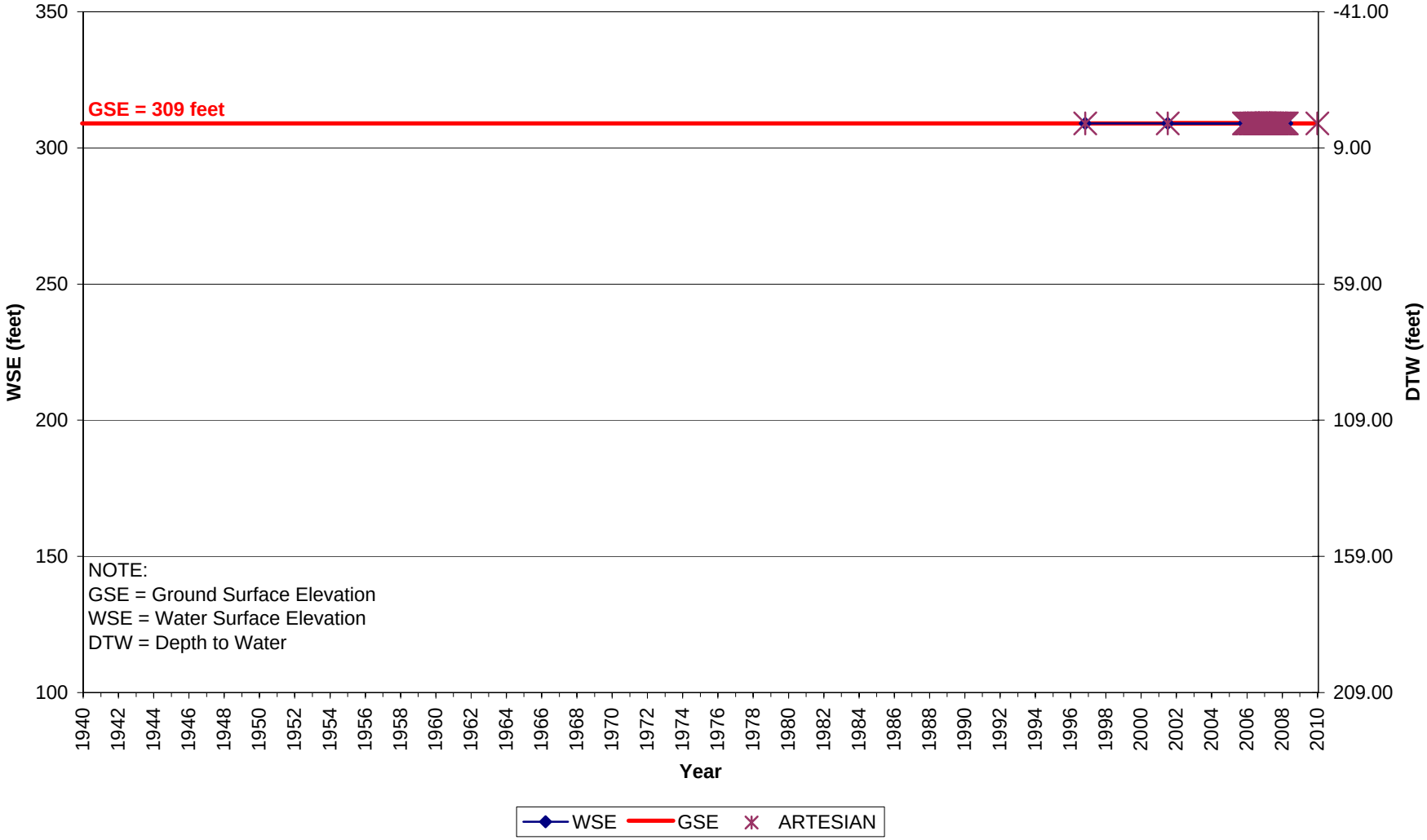
City of Santa Rosa: Groundwater Level Monitoring
Carley Well [4910009-001]
State Well No: T7N/R7W-18R2



Last Revised: 09/10/2008
O:\C\405\02-06-19\E\GW Monitoring\SR_WaterLevel.xls [C_CARLEY YR-MONTHLY]

West Yost Associates

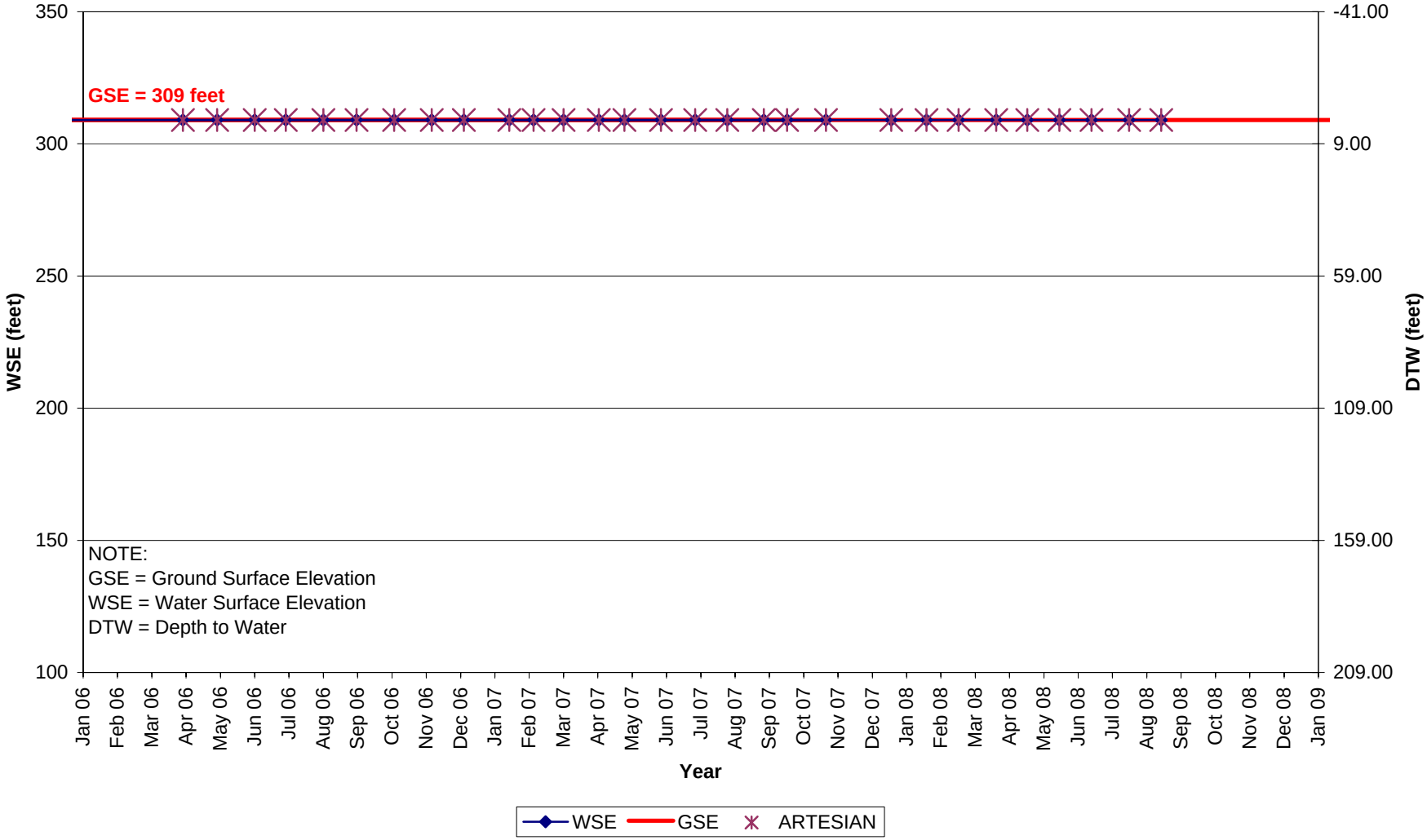
City of Santa Rosa: Groundwater Level Monitoring
Leete Well [4910009-004]
State Well No:



Last Revised: 09/10/2008
O:\C\405\02-06-19\E\GW Monitoring\SR_WaterLevel.xls [C_LEETE]

West Yost Associates

City of Santa Rosa: Groundwater Level Monitoring
Leete Well [4910009-004]
State Well No:



Last Revised: 09/10/2008
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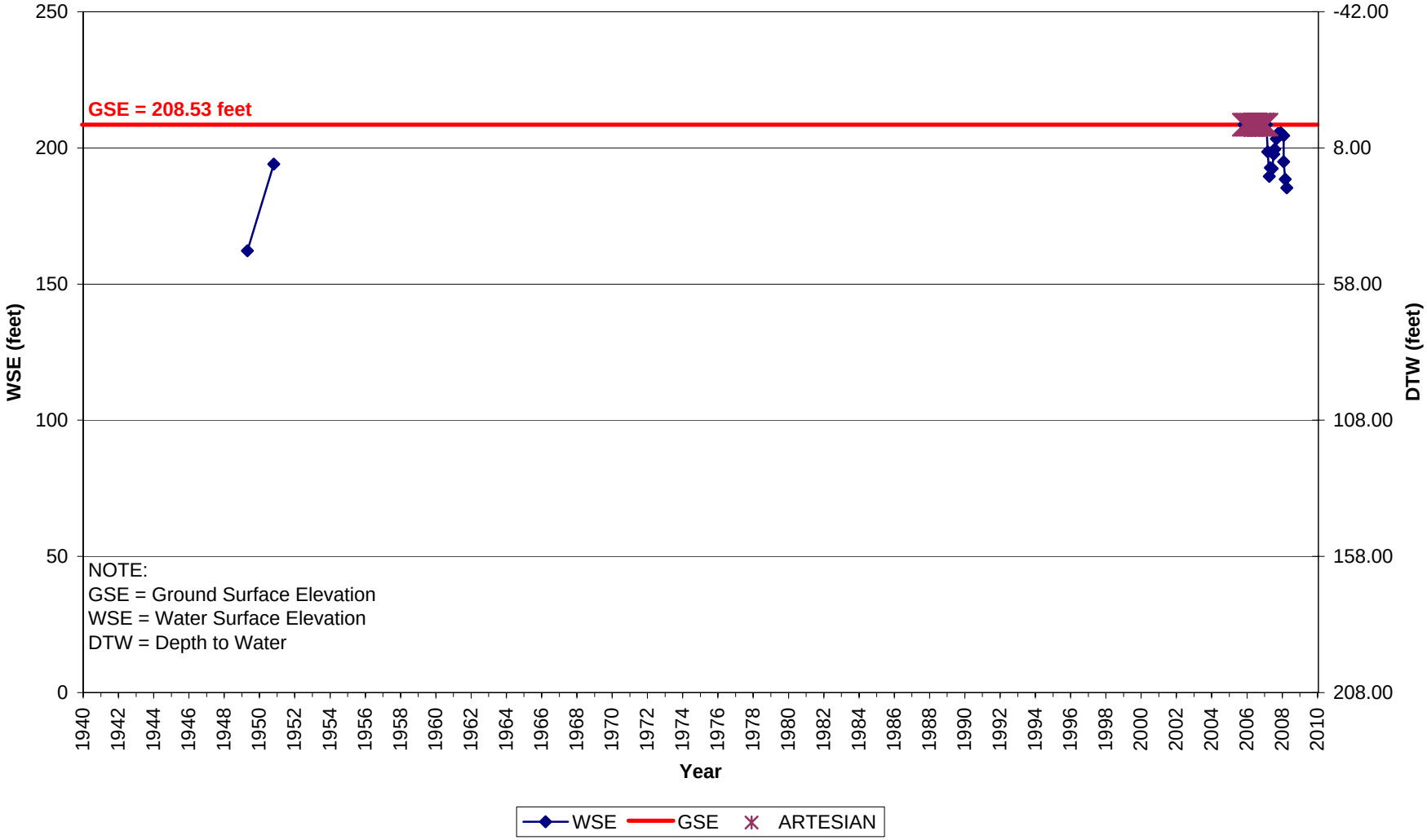
West Yost Associates

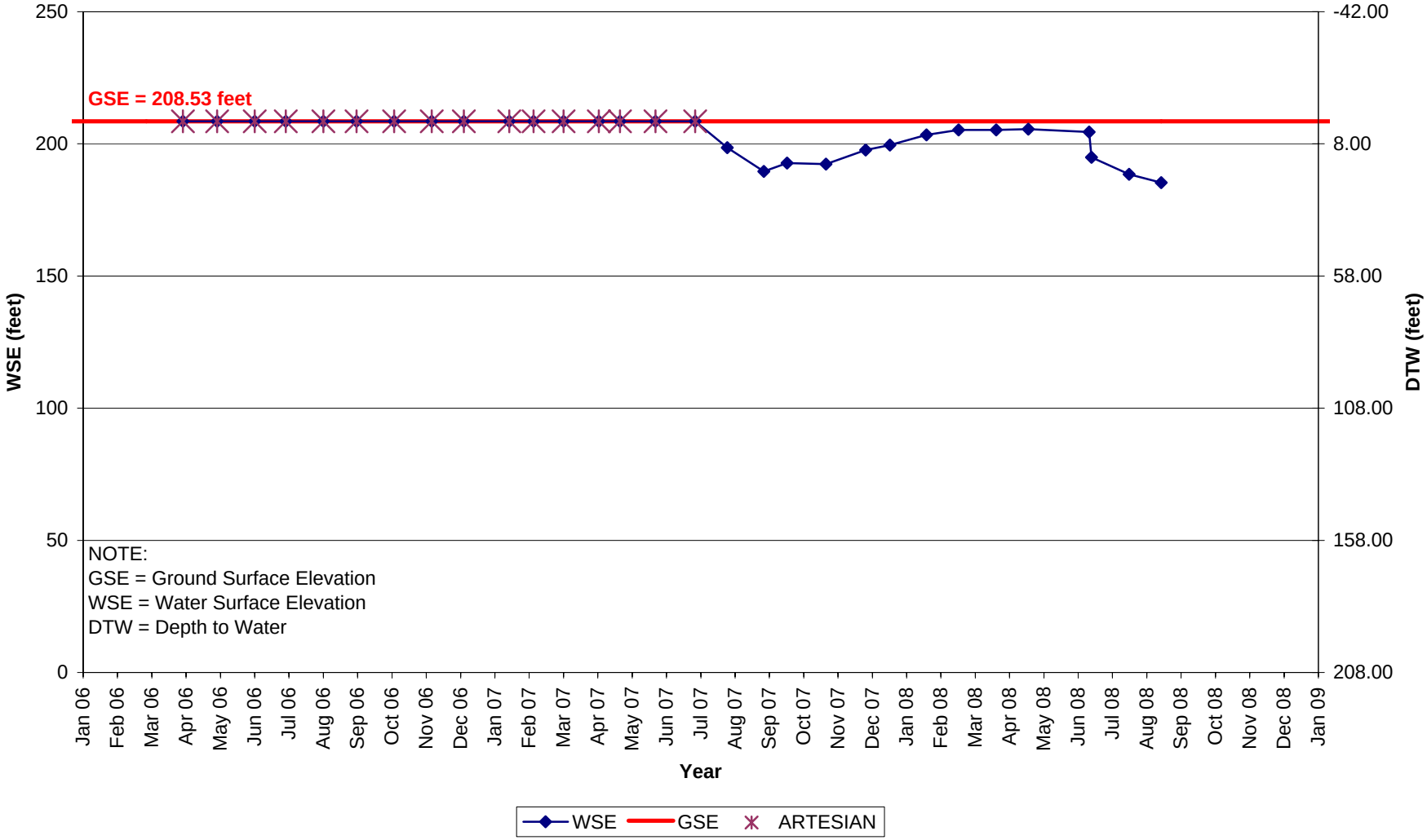
City of Santa Rosa: Groundwater Level Monitoring
Peter Springs Well [4910009-005]
State Well No: T7N/R7W-18R1



Last Revised: 09/10/2008
O:\C\405\02-06-19\E\GW Monitoring\SR_WaterLevel.xls [C_PETER SPRINGS]

West Yost Associates

City of Santa Rosa: Groundwater Level Monitoring
Peter Springs Well [4910009-005]
State Well No: T7N/R7W-18R1



Last Revised: 09/10/2008
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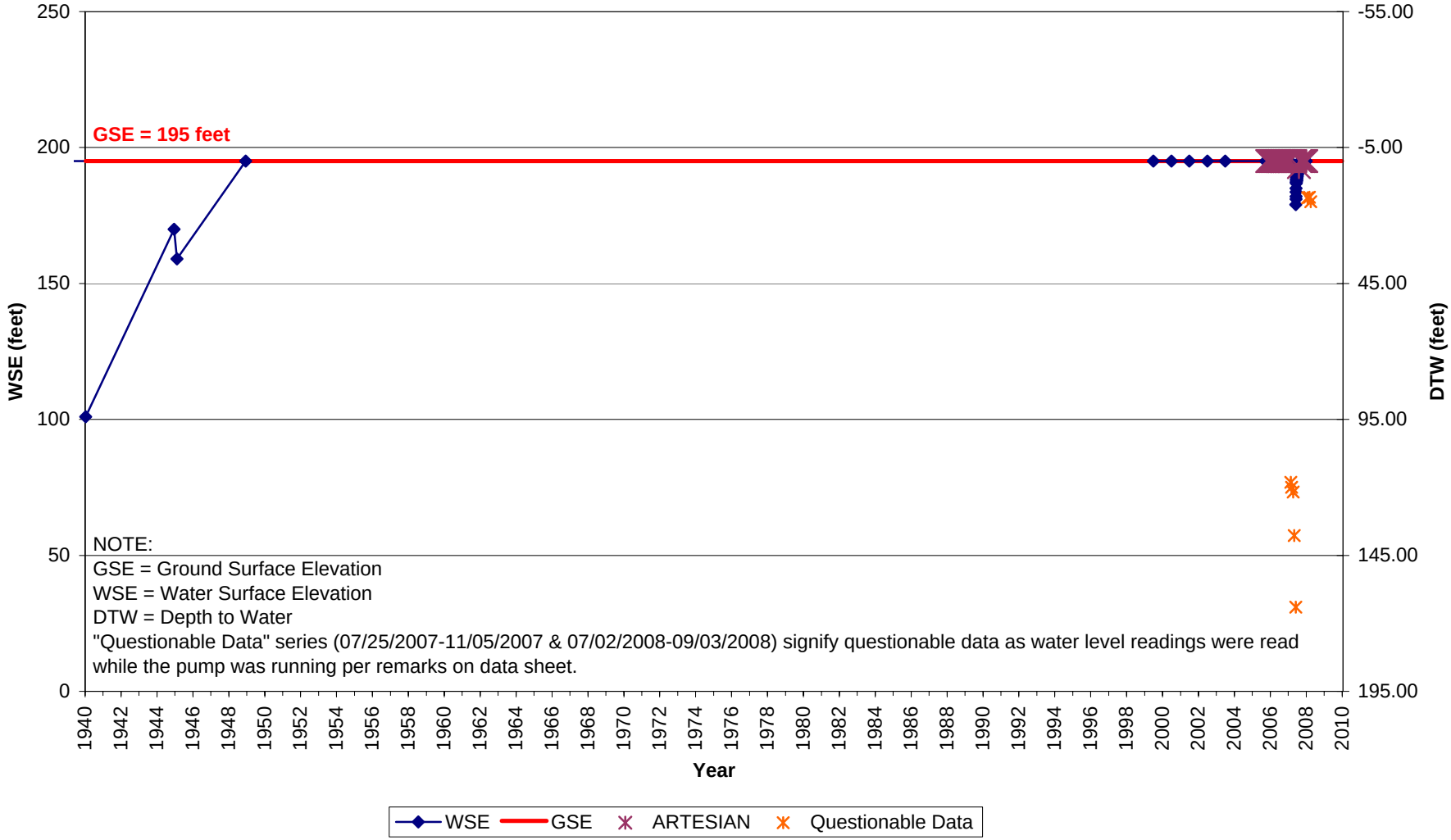
West Yost Associates

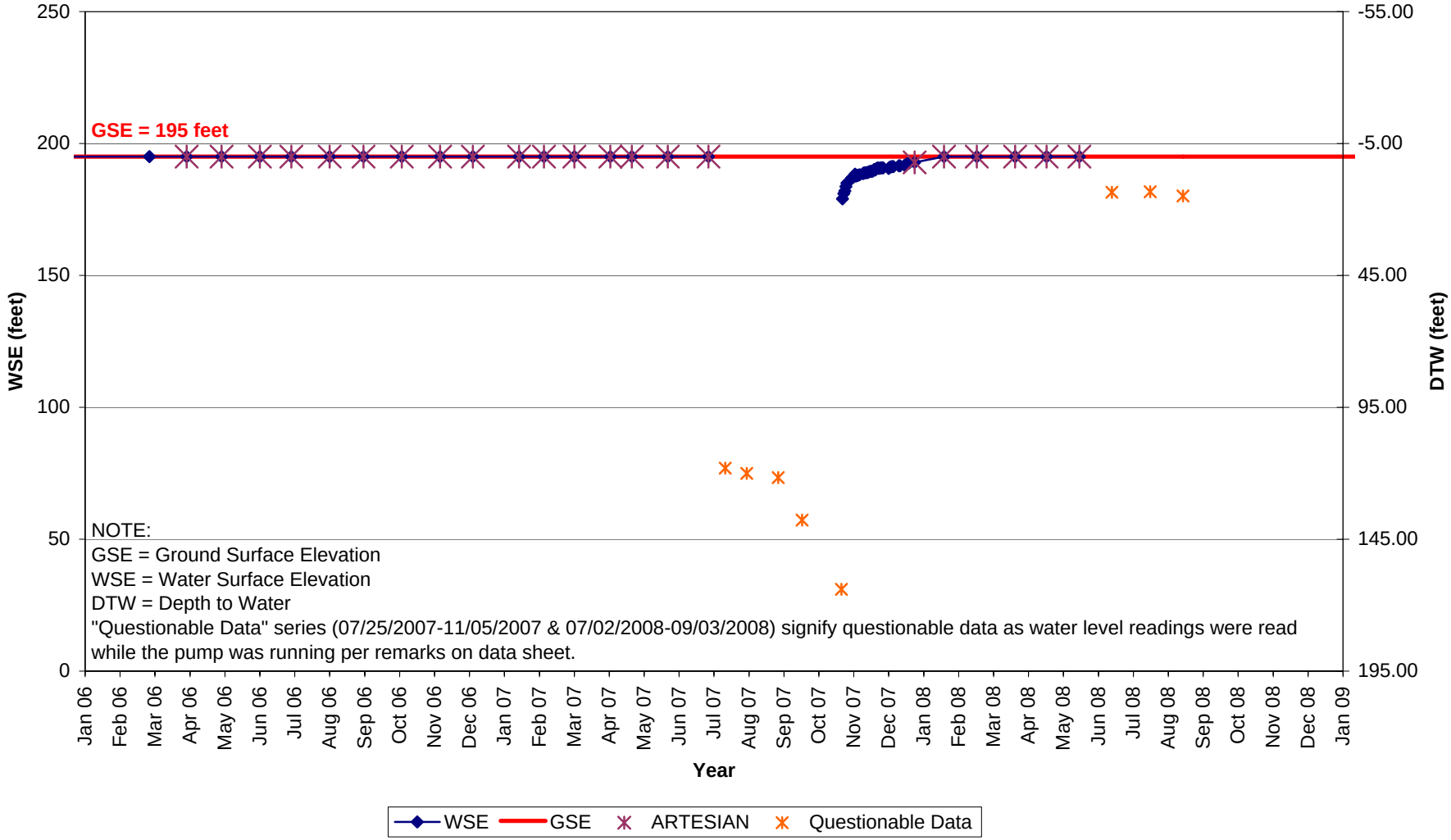
City of Santa Rosa: Groundwater Level Monitoring
Farmers Lane Well 01 [4910009-007]
State Well No: T7N/R8W-24R4



Last Revised: 09/10/2008
O:\C\405\02-06-19\E\GW Monitoring\SR_WaterLevel.xls [C_FARMERS LAND 01]

West Yost Associates

City of Santa Rosa: Groundwater Level Monitoring
Farmers Lane Well 01 [4910009-007]
State Well No: T7N/R8W-24R4



Last Revised: 09/10/2008
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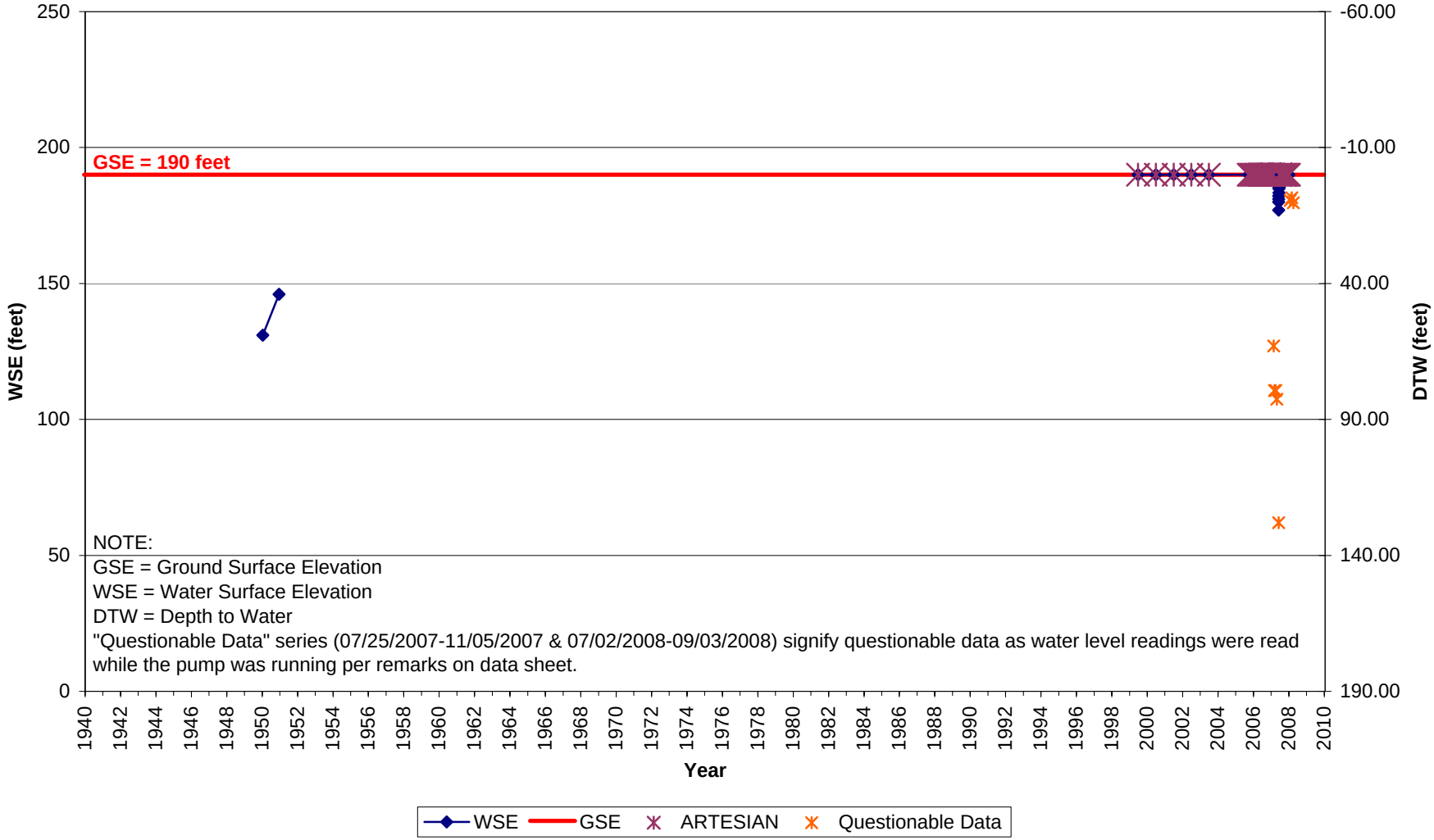
West Yost Associates

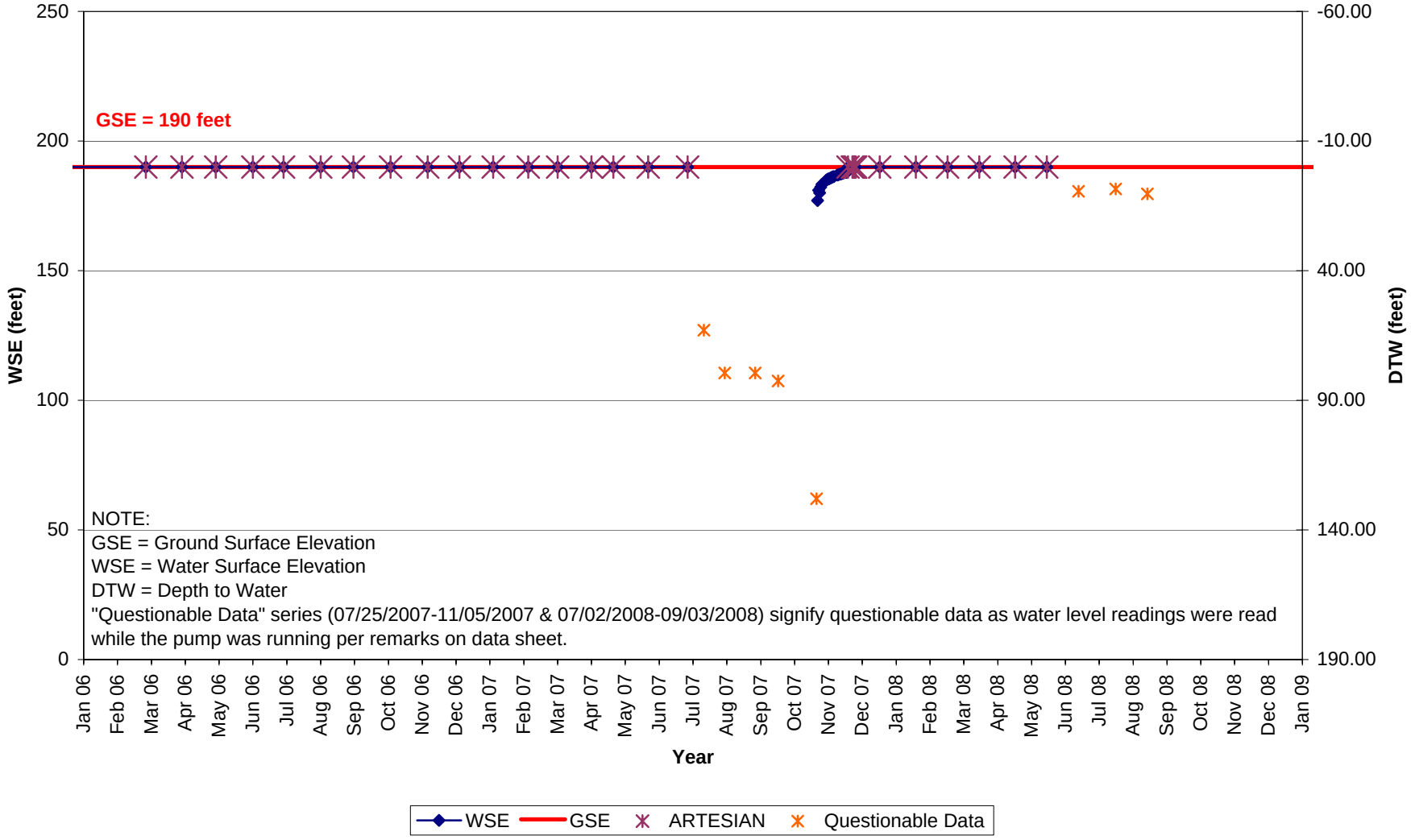
City of Santa Rosa: Groundwater Level Monitoring
Farmers Lane Well 02 [4910009-008]
State Well No: T7N/R8W-24R6



Last Revised: 09/10/2008
O:\C\405\02-06-19\E\GW Monitoring\SR_WaterLevel.xls [C_FARMERS LAND 02]

West Yost Associates

City of Santa Rosa: Groundwater Level Monitoring
Farmers Lane Well 02 [4910009-008]
State Well No: T7N/R8W-24R6



Last Revised: 09/10/2008
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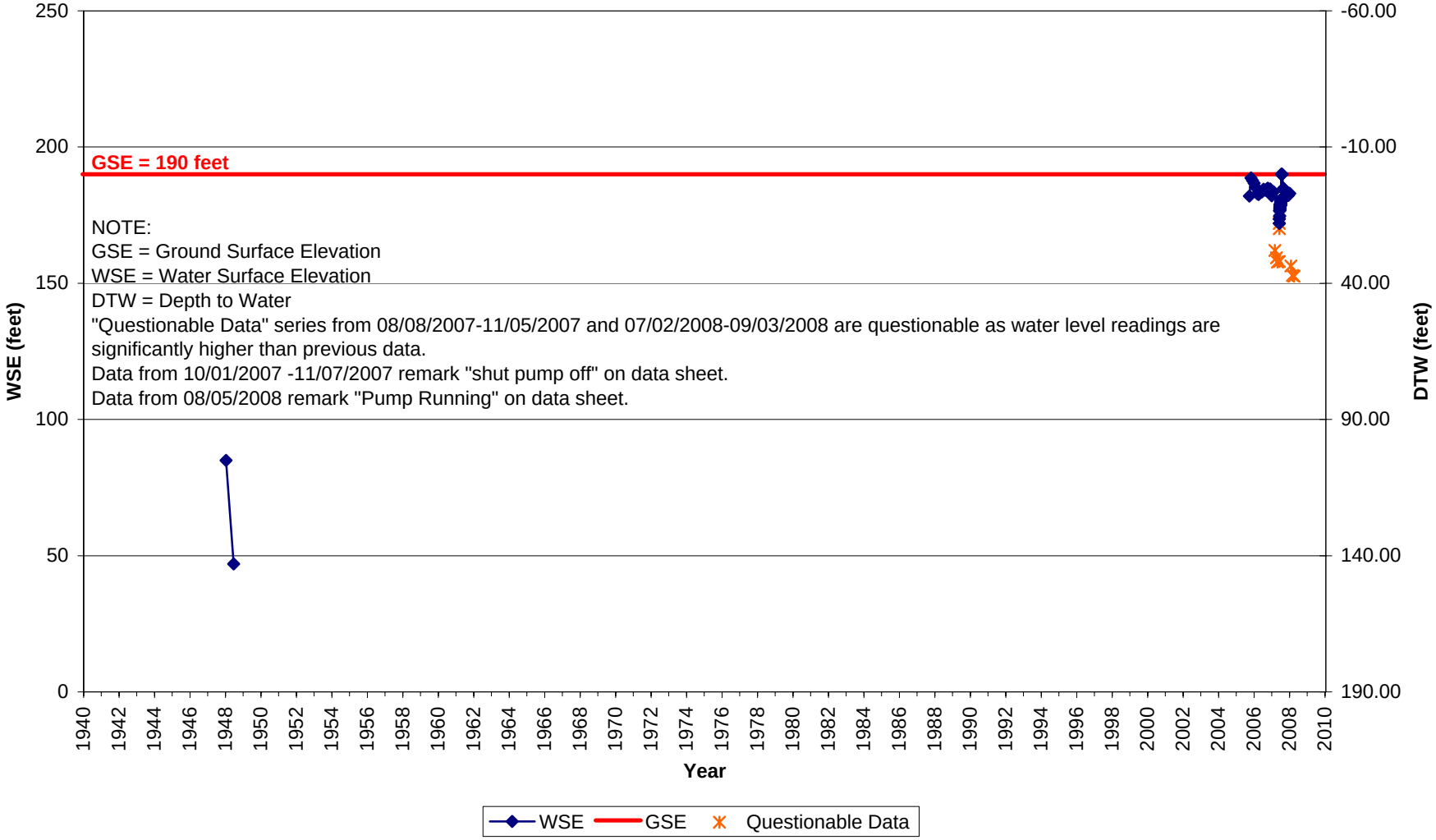
West Yost Associates

City of Santa Rosa: Groundwater Level Monitoring
Farmers Lane Well 03 [4910009-009]
State Well No: T7N/R8W-24R5



Last Revised: 09/10/2008
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West Yost Associates

City of Santa Rosa: Groundwater Level Monitoring
Farmers Lane Well 03 [4910009-009]
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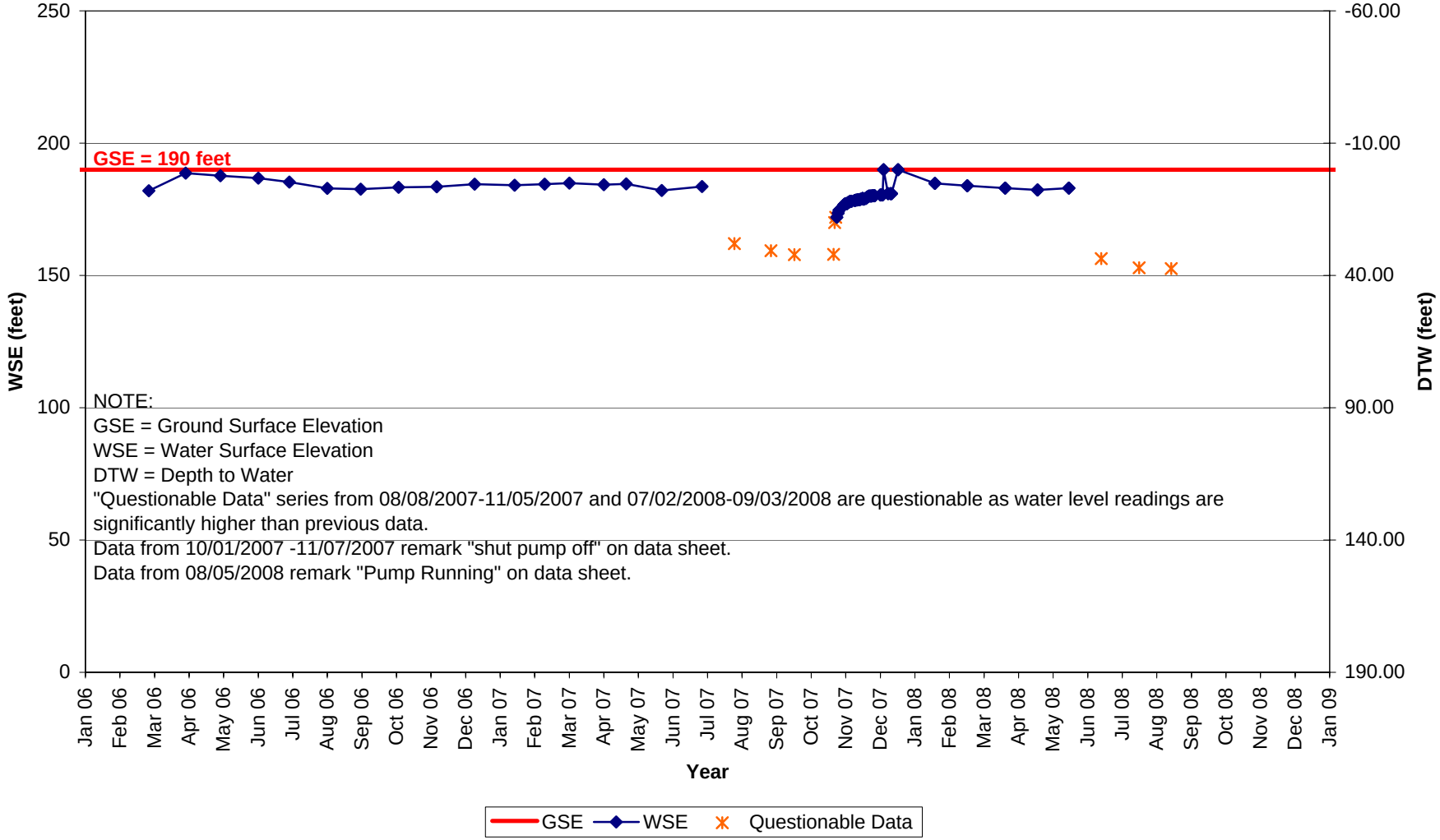


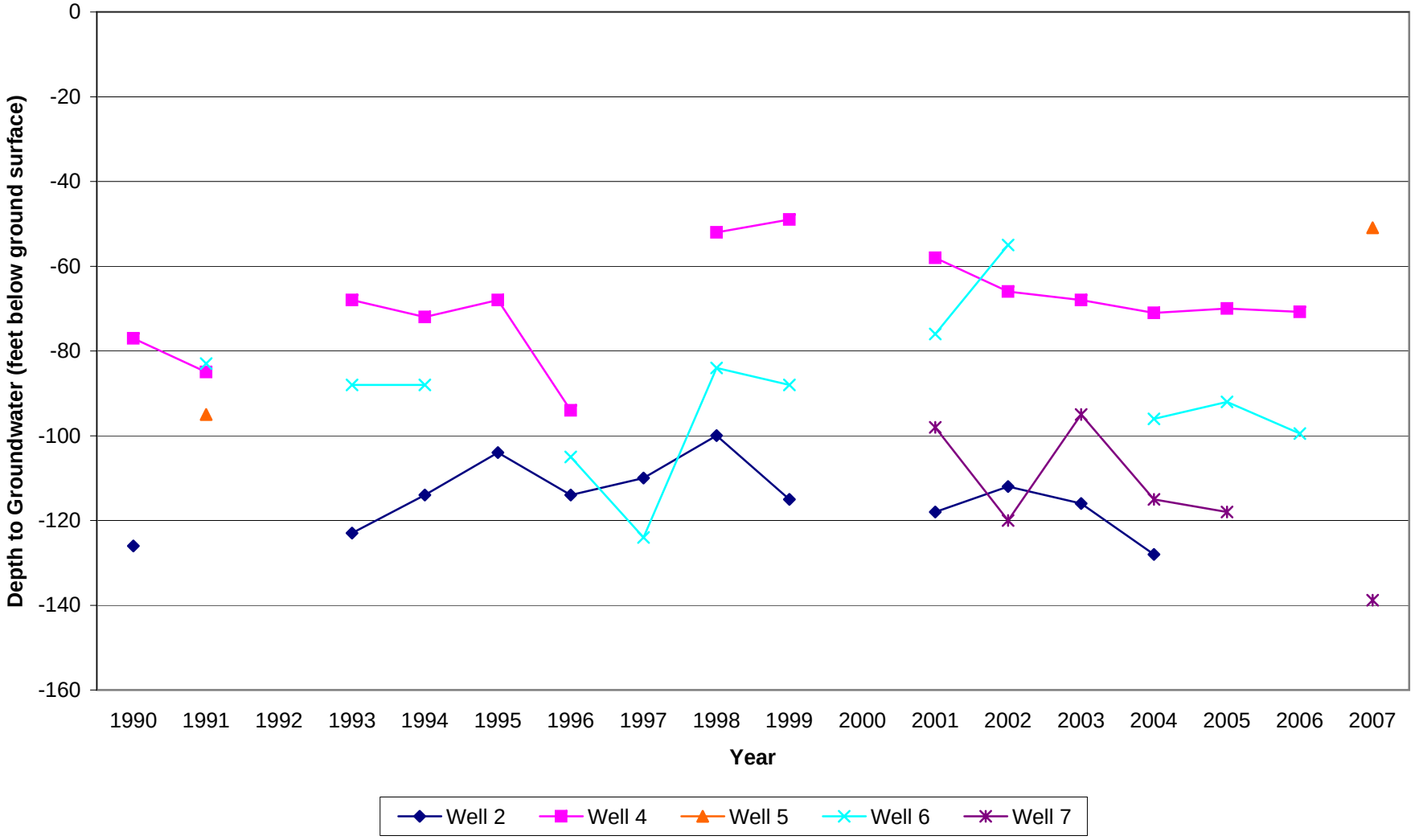
Last Revised: 09/10/2008
O:\C\405\02-06-19\E\GW Monitoring\SR_WaterLevel.xls [C_FARMERS LAND 03 YR-MONTHLY]

West Yost Associates

Appendix C

City of Sebastopol Well Hydrographs

City of Sebastopol Depth to Groundwater
(Spring (March/April) measurements); feet below ground surface)



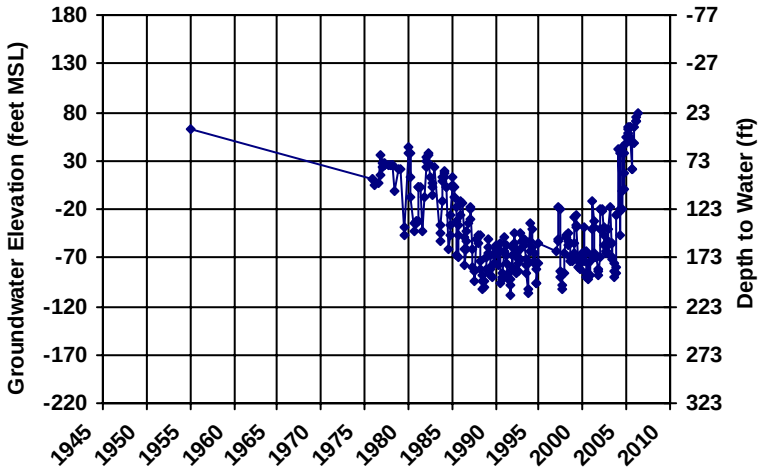
Drawdowns from January 2004.xls: Fig X. GW Levels
Last Revised: September 23, 2008

West Yost Associates

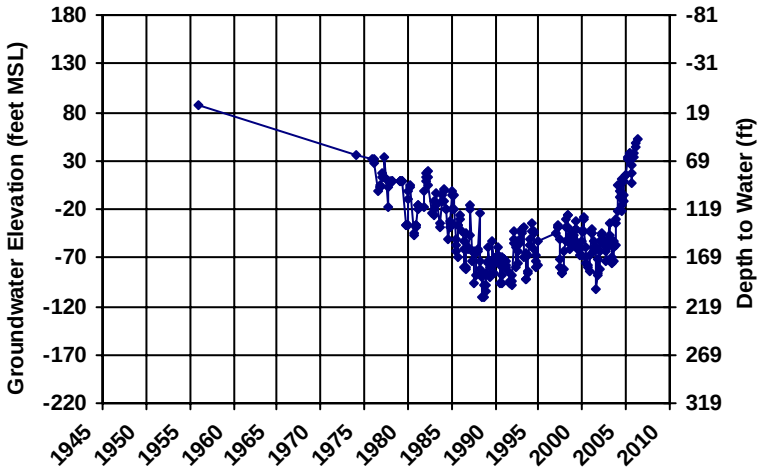
Appendix D

City of Rohnert Park Well Hydrographs

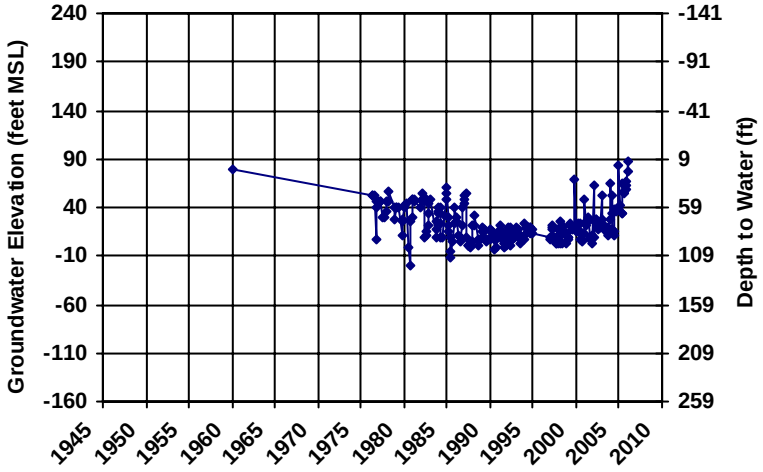
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_01 (RP_01) RPE: 103



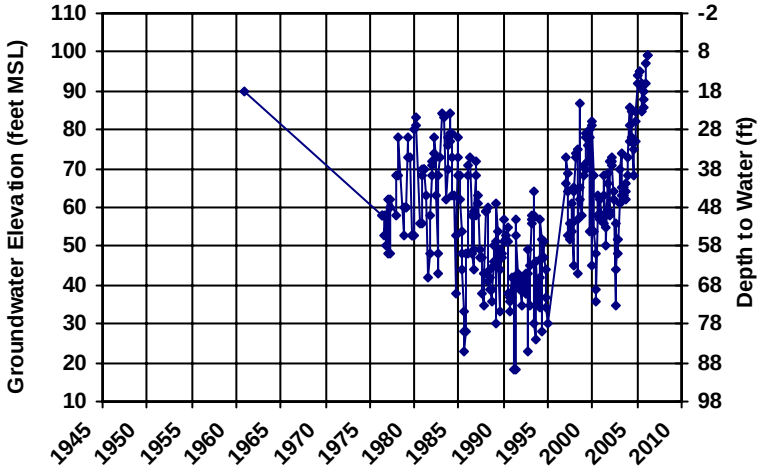
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_02 (RP_02) RPE: 99



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: IDL
Depth if available:
State Well Number: RP_03 (RP_03) RPE: 99

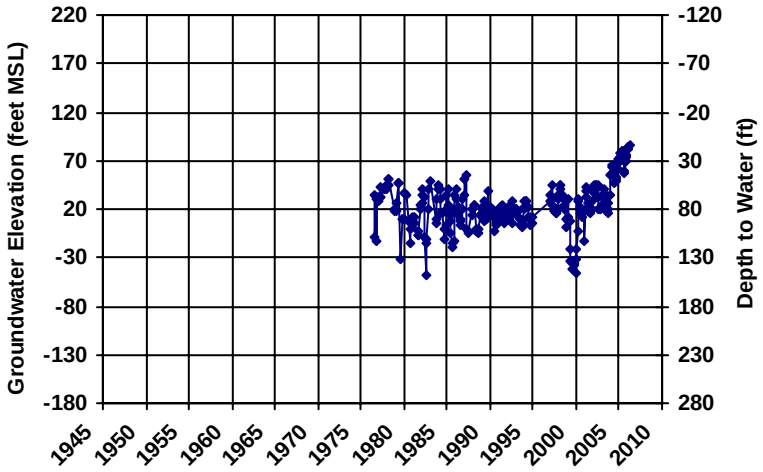


SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_04 (RP_04) RPE: 108

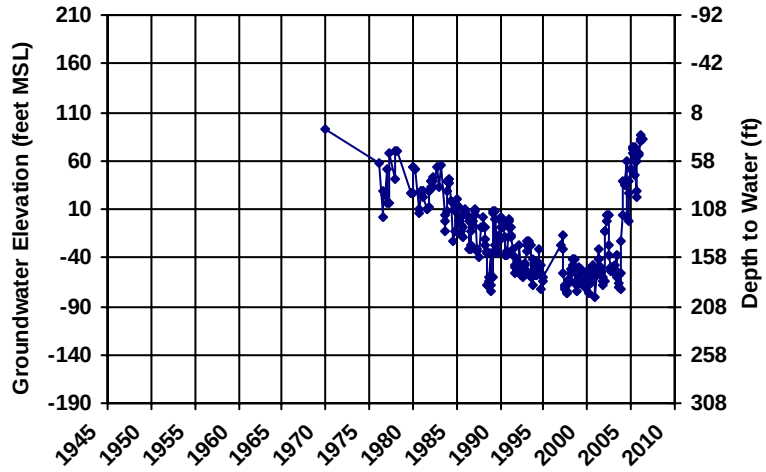


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

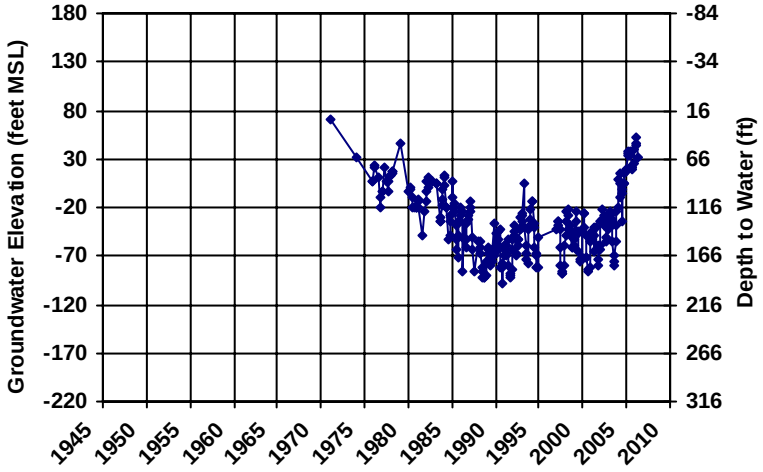
SANTA ROSA VALLEY
SANTA ROSA PLAIN
State Well Number: RP_05 (RP_05)
Aquifer: SI
Depth if available:
RPE: 100



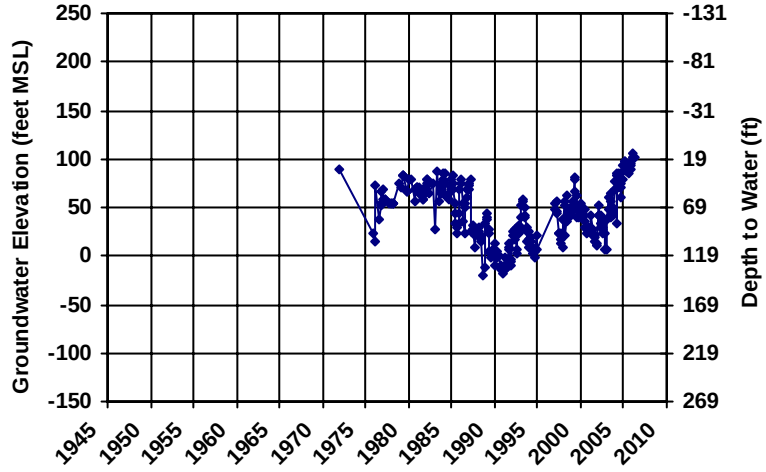
SANTA ROSA VALLEY
SANTA ROSA PLAIN
State Well Number: RP_06 (RP_06)
Aquifer: SI
Depth if available:
RPE: 118



SANTA ROSA VALLEY
SANTA ROSA PLAIN
State Well Number: RP_07 (RP_07)
Aquifer: SI
Depth if available:
RPE: 96

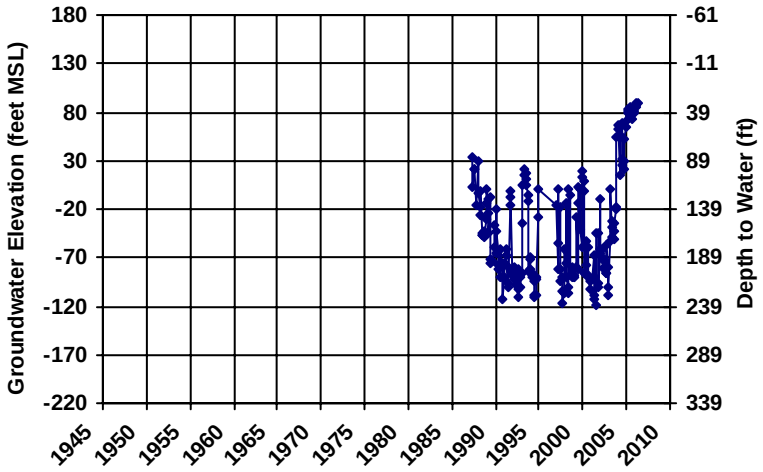


SANTA ROSA VALLEY
SANTA ROSA PLAIN
State Well Number: RP_08 (RP_08)
Aquifer: SI
Depth if available:
RPE: 119

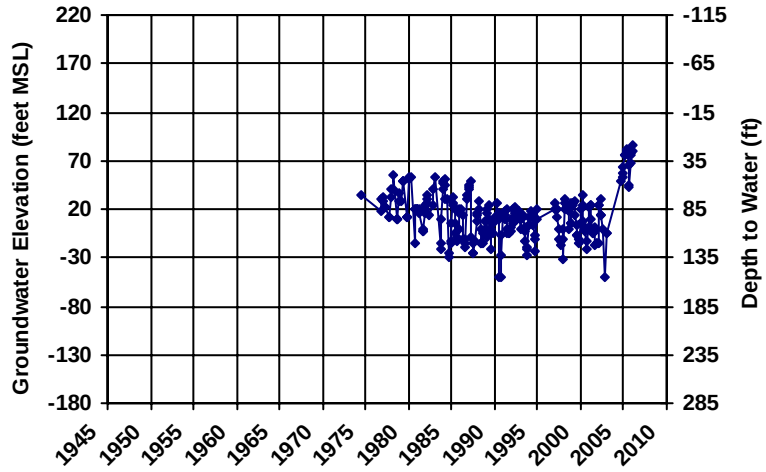


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

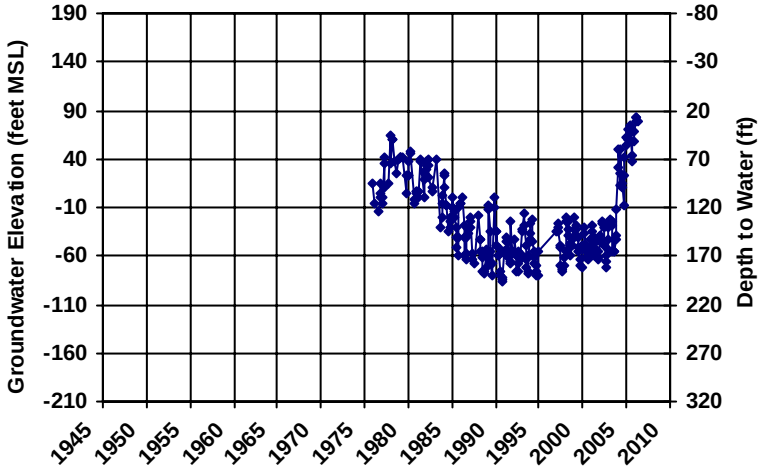
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_08A (RP_08A) RPE: 119



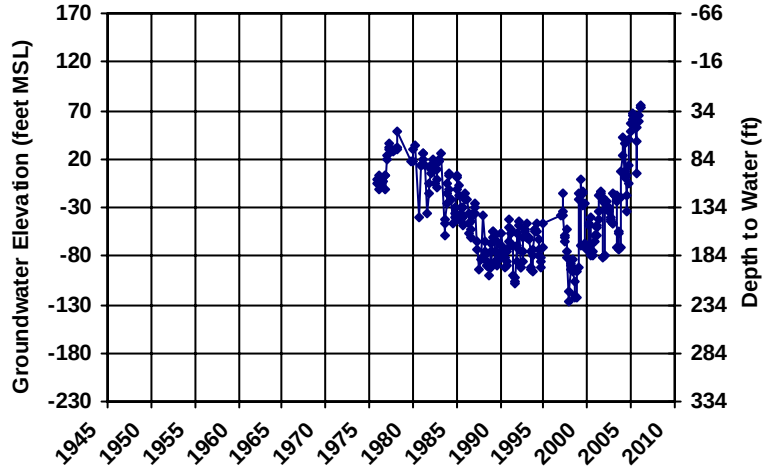
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_09 (RP_09) RPE: 105



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_10 (RP_10) RPE: 110

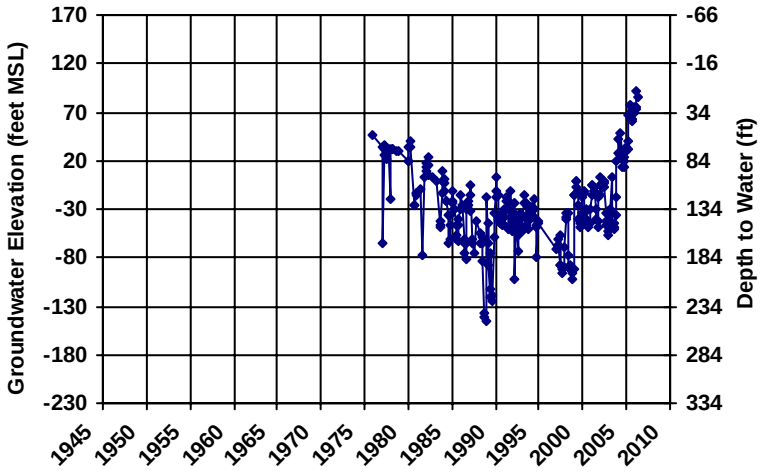


SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_11 (RP_11) RPE: 104

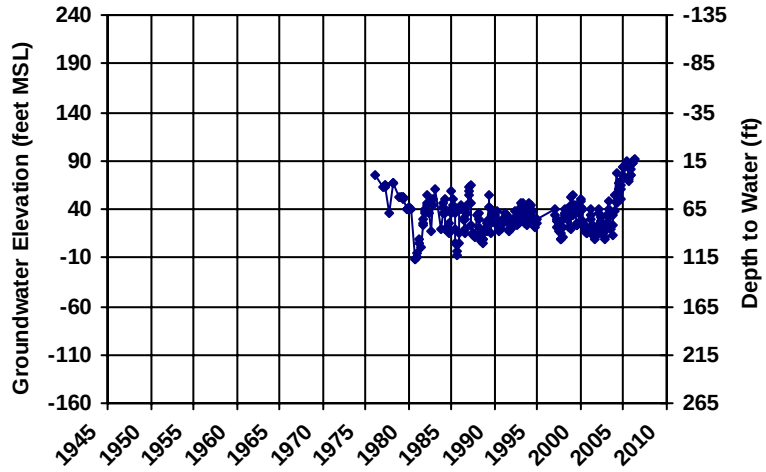


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

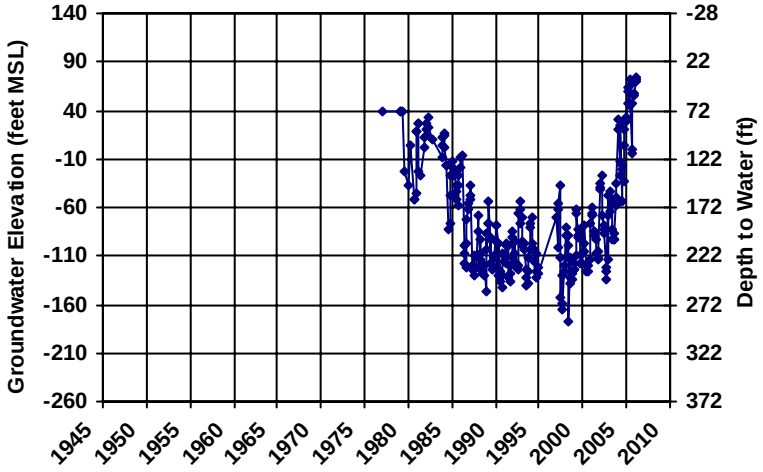
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_12 (RP_12) RPE: 104



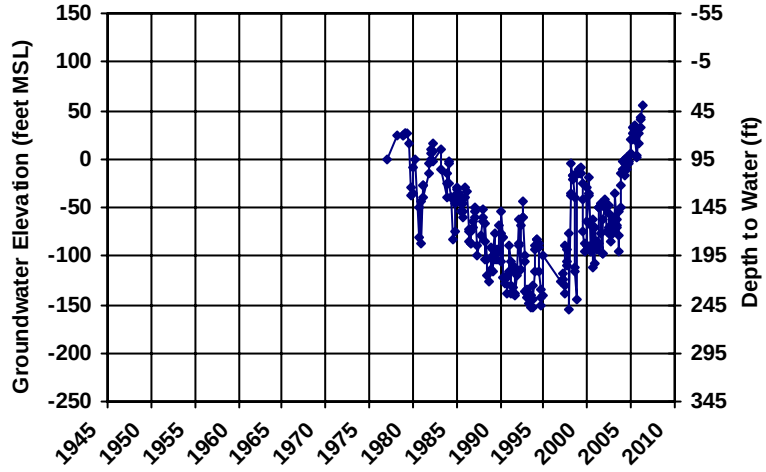
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_13 (RP_13) RPE: 105



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: IDL
Depth if available:
State Well Number: RP_14 (RP_14) RPE: 112

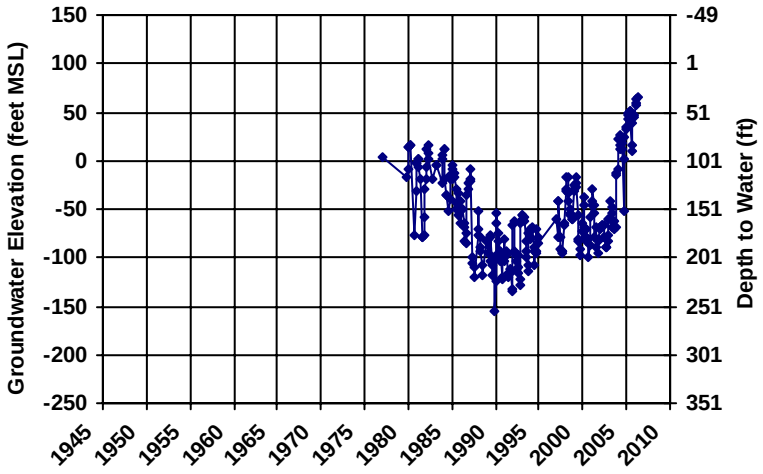


SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: IDL
Depth if available:
State Well Number: RP_15 (RP_15) RPE: 95

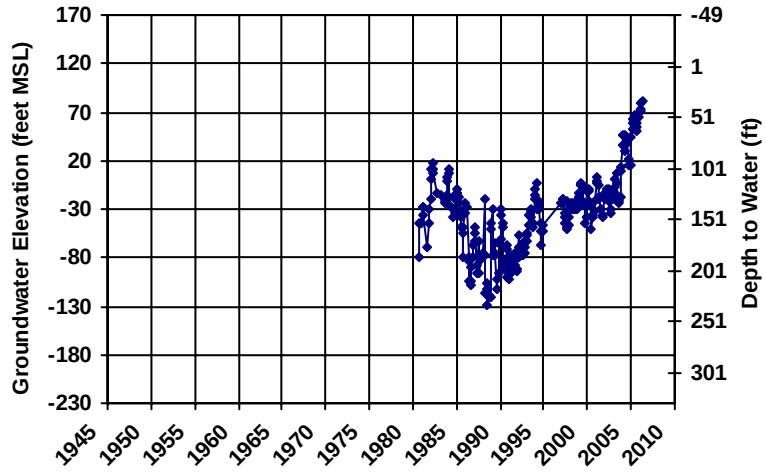


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

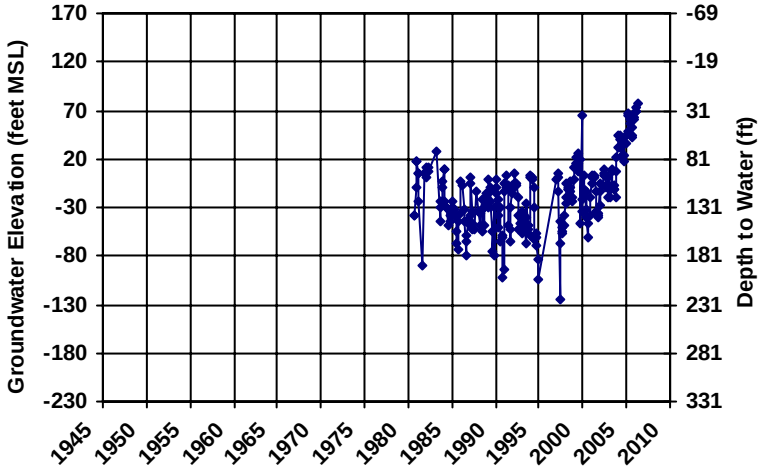
SANTA ROSA VALLEY
SANTA ROSA PLAIN
State Well Number: RP_16 (RP_16)
Aquifer: IDL
Depth if available:
RPE: 101



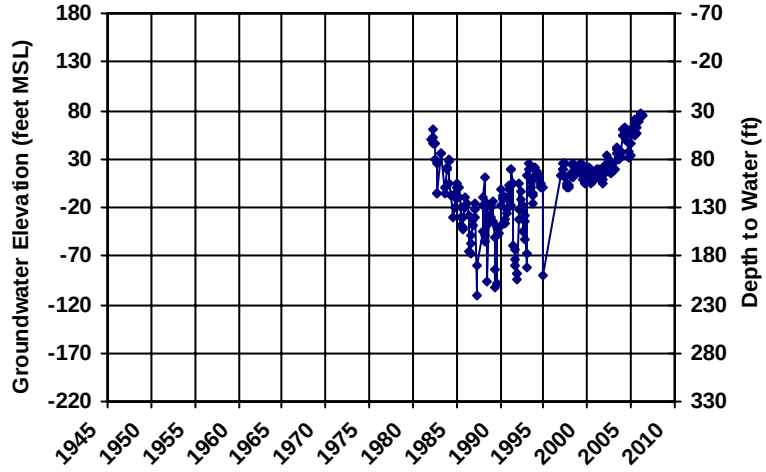
SANTA ROSA VALLEY
SANTA ROSA PLAIN
State Well Number: RP_17 (RP_17)
Aquifer: I
Depth if available:
RPE: 101



SANTA ROSA VALLEY
SANTA ROSA PLAIN
State Well Number: RP_18 (RP_18)
Aquifer: I
Depth if available:
RPE: 101

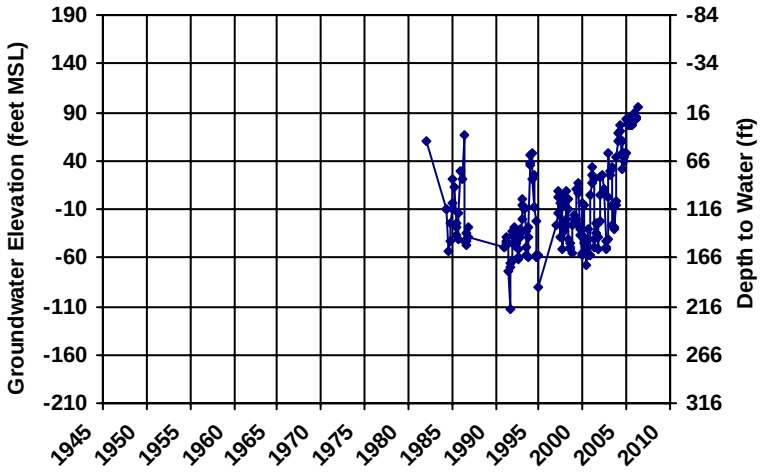


SANTA ROSA VALLEY
SANTA ROSA PLAIN
State Well Number: RP_19 (RP_19)
Aquifer: SI
Depth if available:
RPE: 110

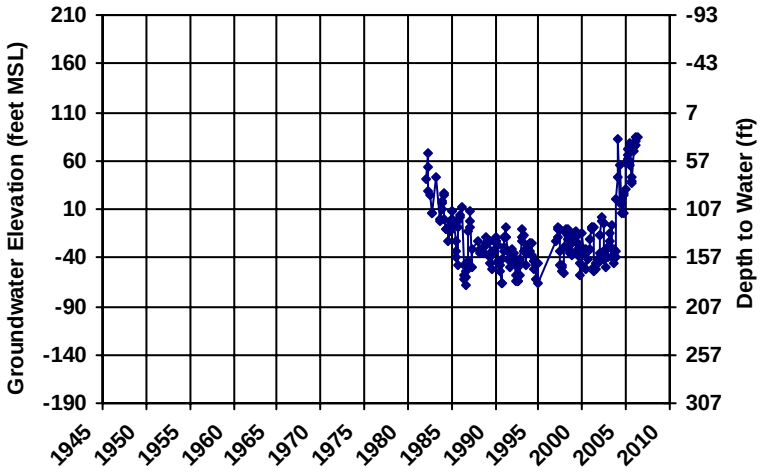


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

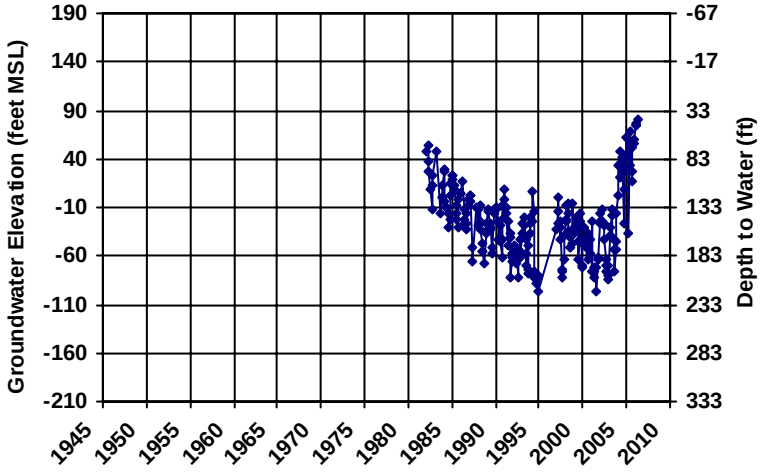
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_20 (RP_20) RPE: 106



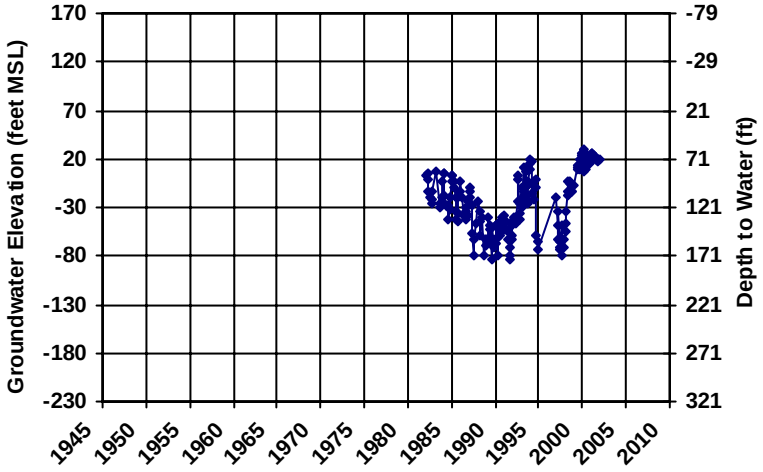
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_21 (RP_21) RPE: 117



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_22 (RP_22) RPE: 123

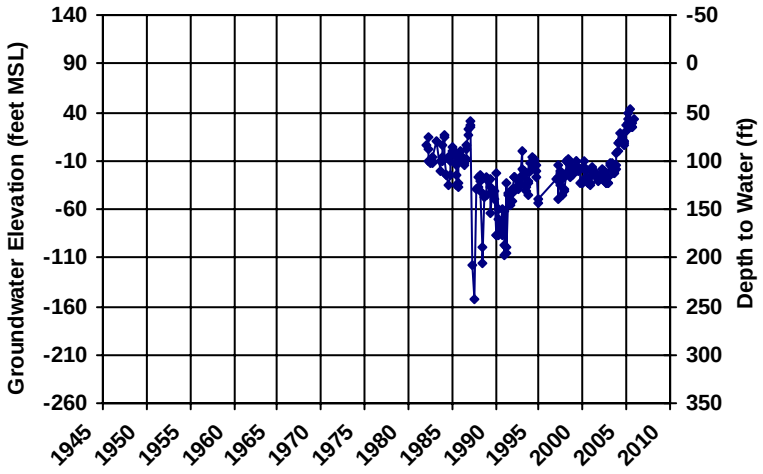


SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_23 (RP_23) RPE: 91

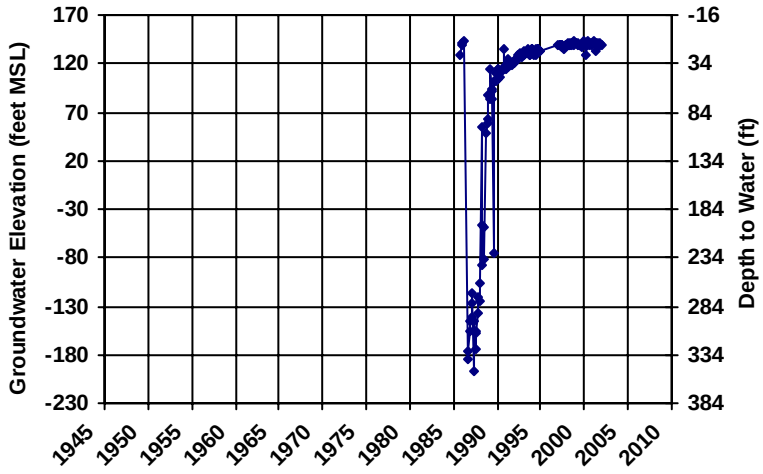


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

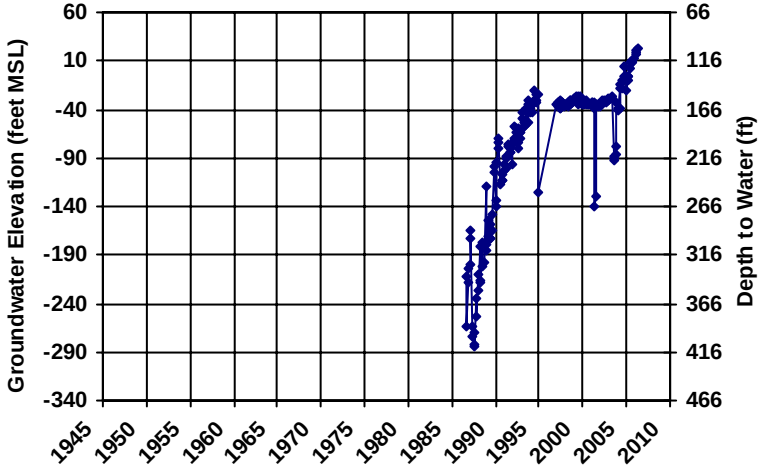
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_24 (RP_24) RPE: 90



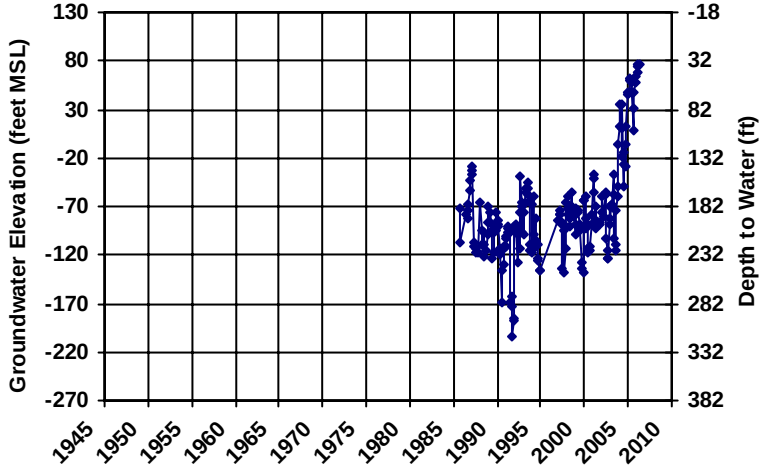
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_25 (RP_25) RPE: 154



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_26 (RP_26) RPE: 126

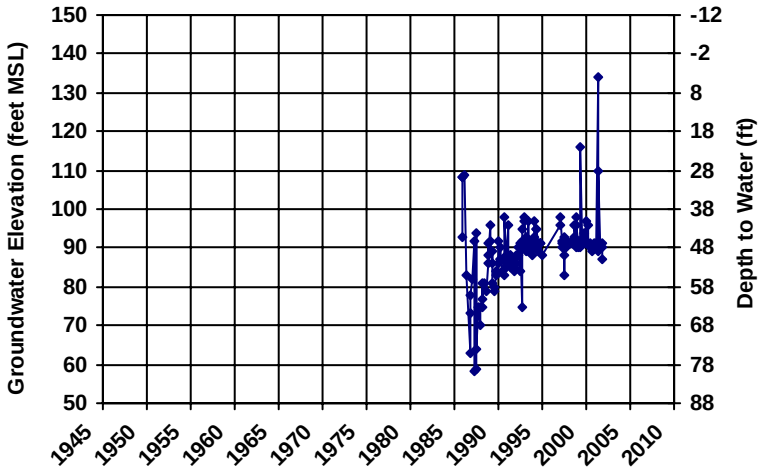


SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_27 (RP_27) RPE: 112

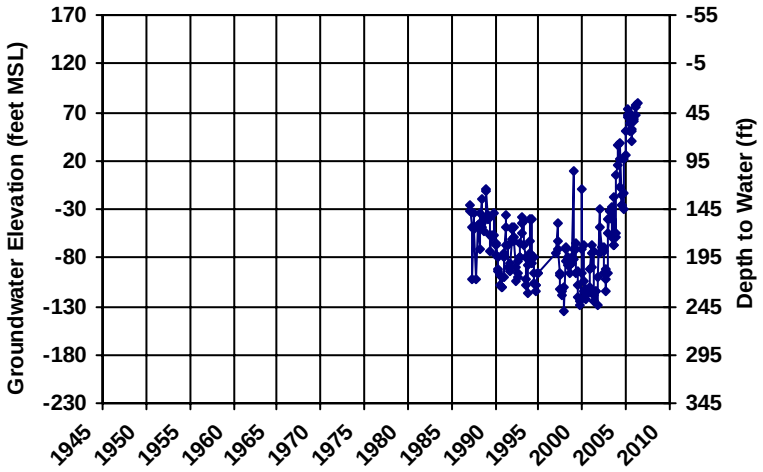


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

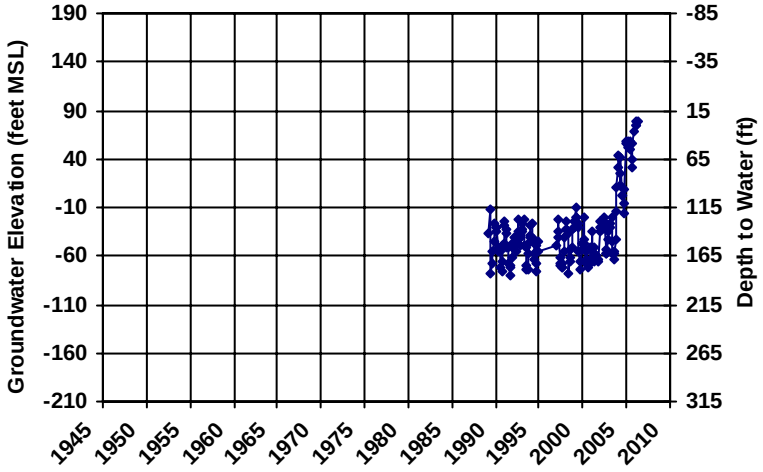
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_28 (RP_28) RPE: 138



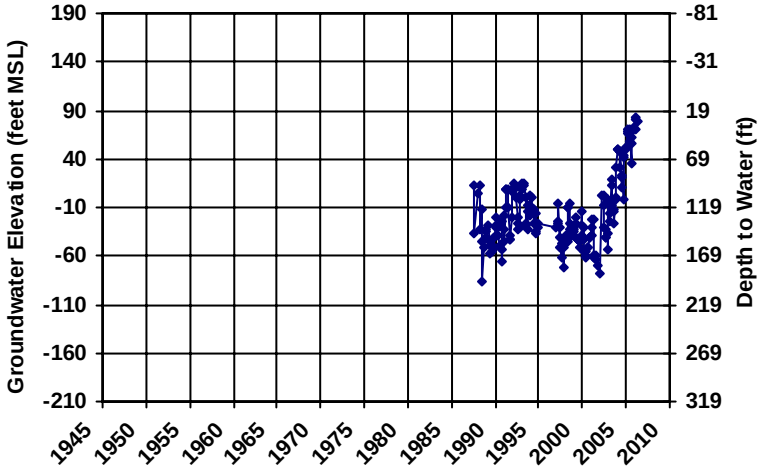
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_29 (RP_29) RPE: 115



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_30 (RP_30) RPE: 105

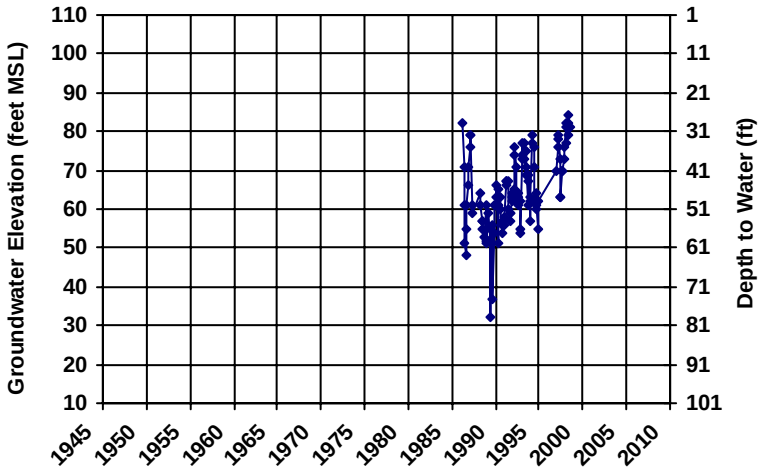


SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_31 (RP_31) RPE: 109

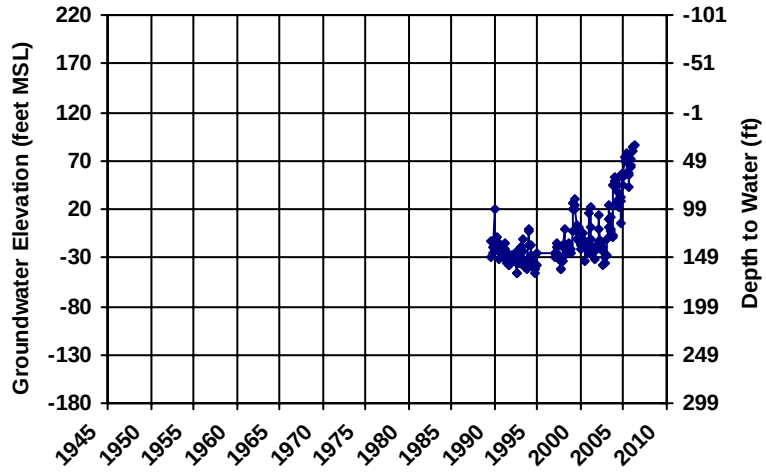


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

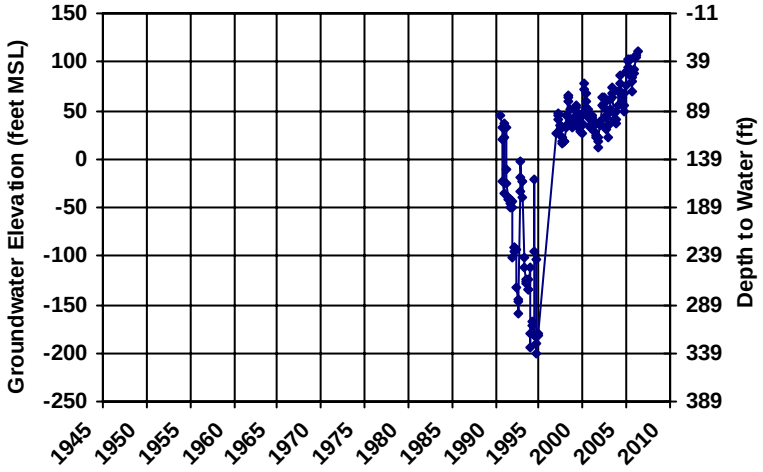
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_32 (RP_32) RPE: 111



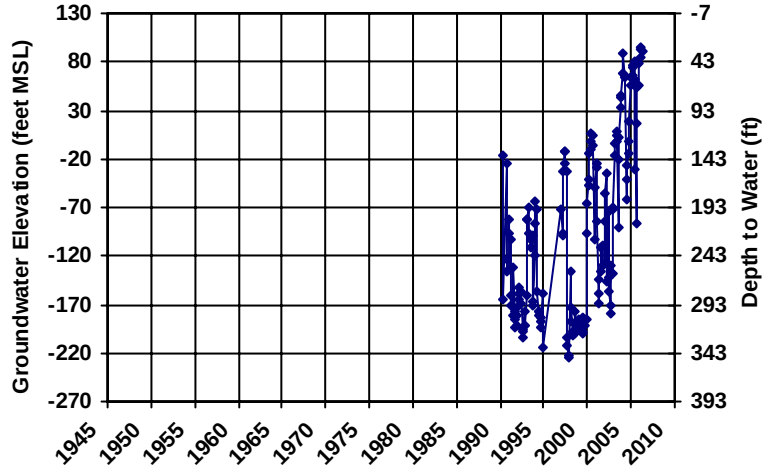
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SID
Depth if available:
State Well Number: RP_33 (RP_33) RPE: 119



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SID
Depth if available:
State Well Number: RP_34 (RP_34) RPE: 139

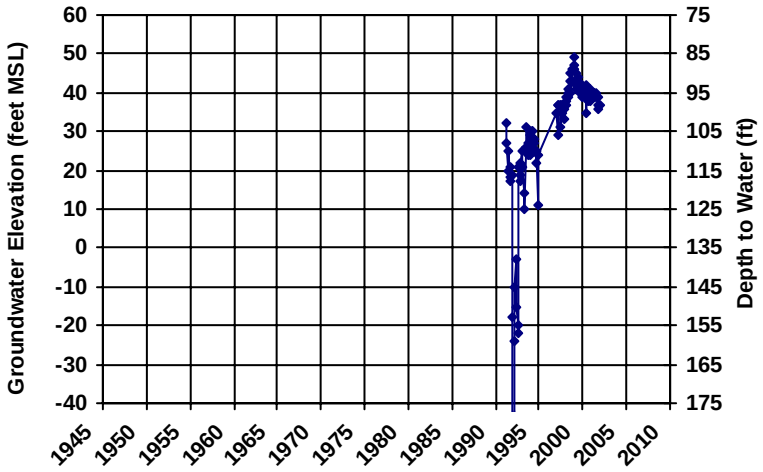


SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_35 (RP_35) RPE: 123

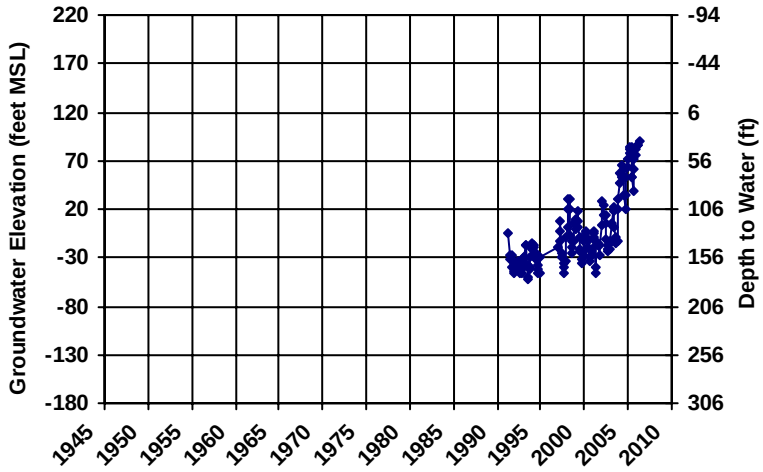


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

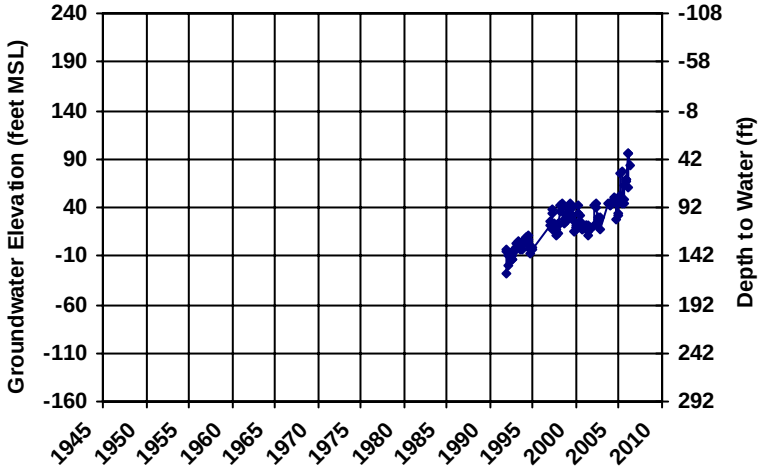
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: ID
Depth if available:
State Well Number: RP_36 (RP_36) RPE: 135



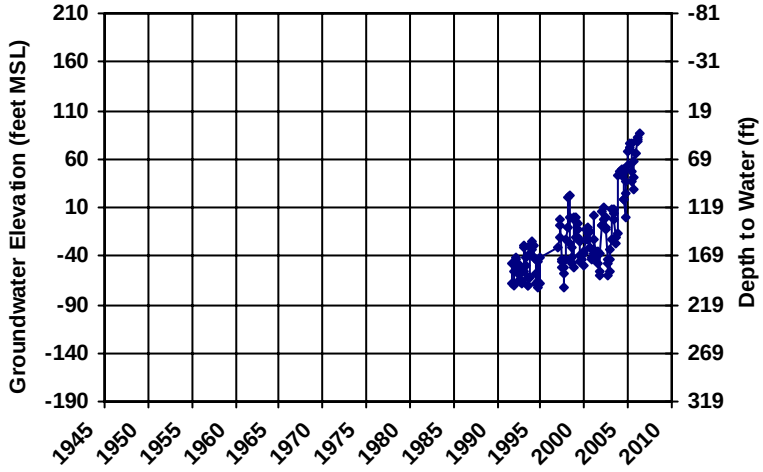
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_37 (RP_37) RPE: 126



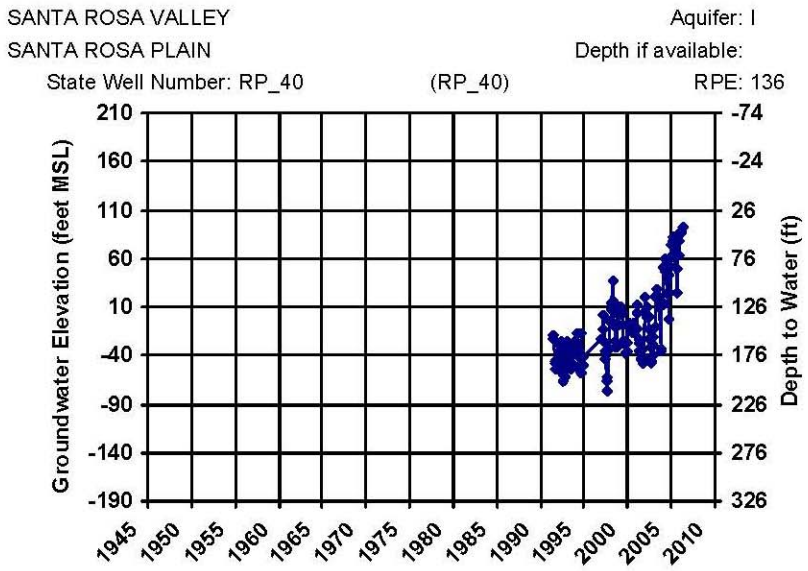
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: SI
Depth if available:
State Well Number: RP_38 (RP_38) RPE: 132

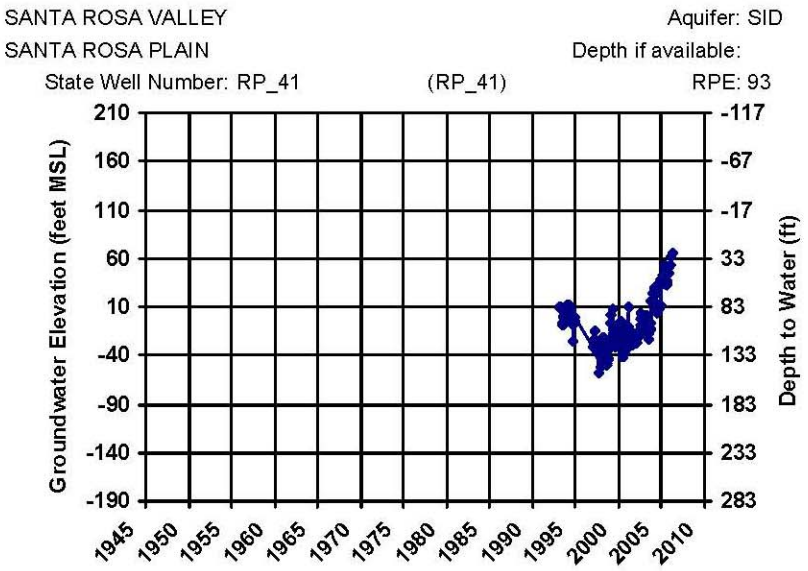


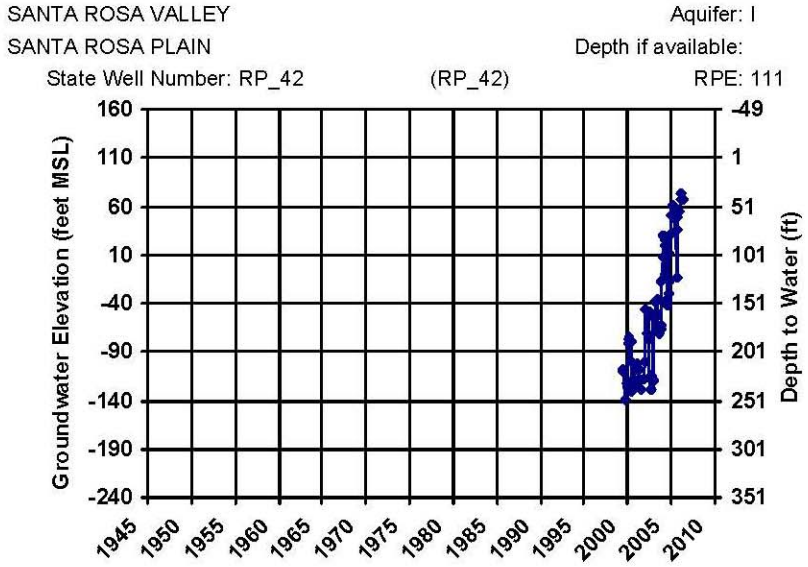
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available:
State Well Number: RP_39 (RP_39) RPE: 129



Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.





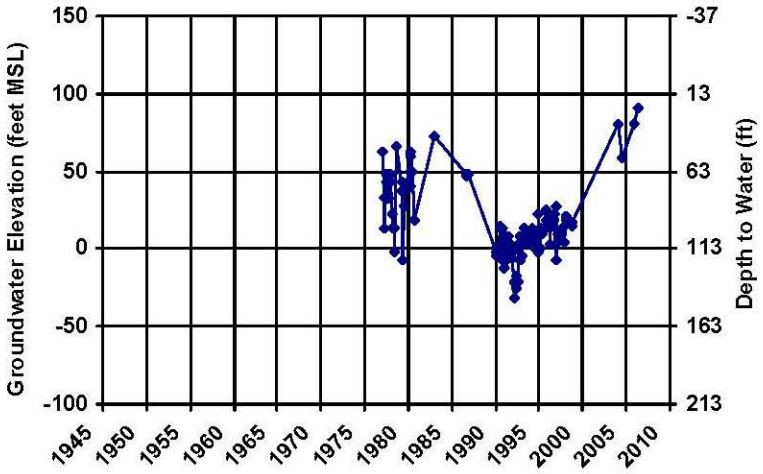


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

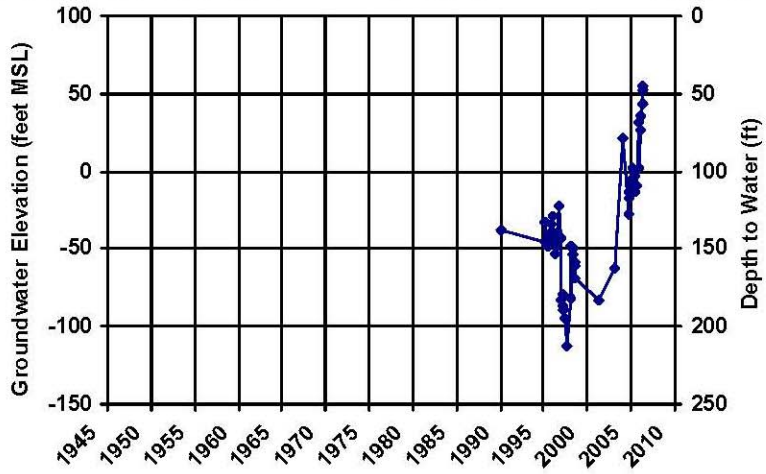
Appendix E

City of Cotati Well Hydrographs

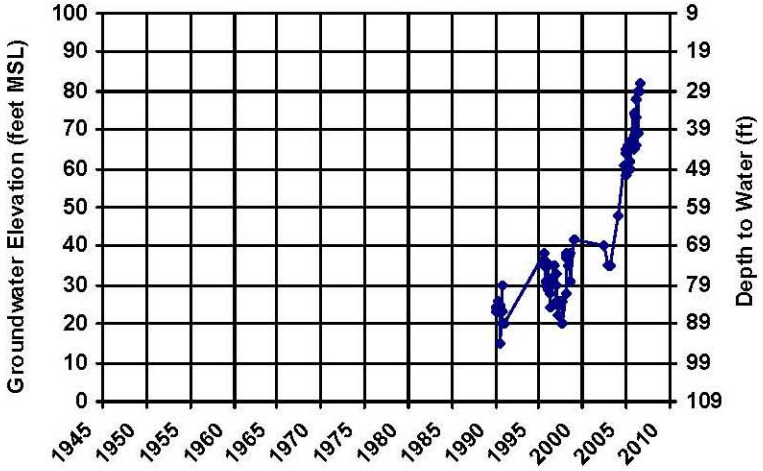
SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: I
Depth if available: 500
State Well Number: COT_02 (COT_02)
RPE: 113



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: ID
Depth if available: 685
State Well Number: COT_03 (COT_03)
RPE: 100



SANTA ROSA VALLEY
SANTA ROSA PLAIN
Aquifer: ID
Depth if available: 650
State Well Number: COT_1A (COT_1A)
RPE: 109

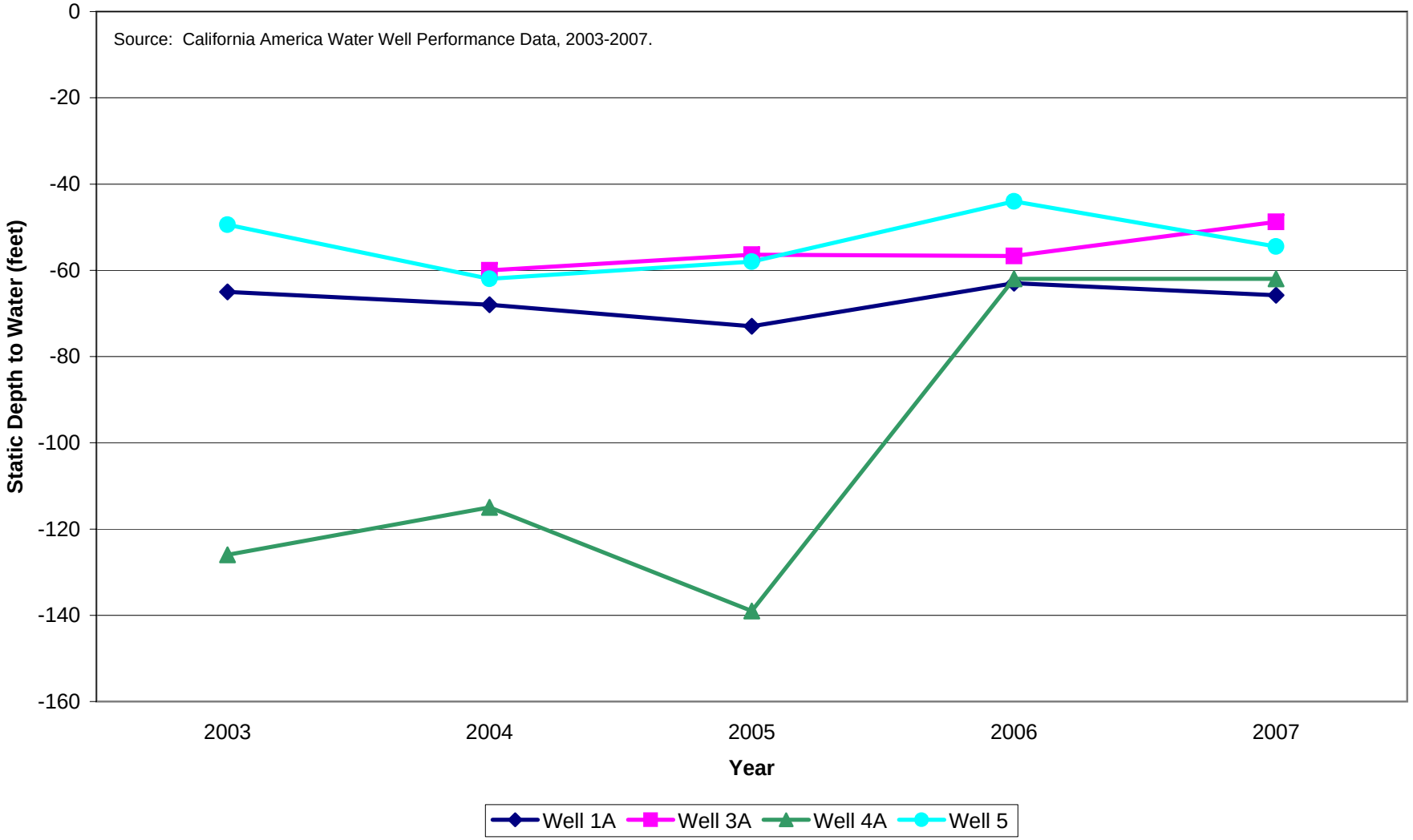


Source: City of Rohnert Park 2005 Urban Water Management Plan, adopted August 28, 2007.

Appendix F

California American Water Well Hydrographs

California American Water--Larkfield District
Historical Water Levels



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