

Appendix F: Appendix F: Hydrology and Water Quality Supporting Information

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F.1 - Stormwater Control Plan

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STORMWATER CONTROL PLAN FOR A REGULATED PROJECT

BROWNS VALLEY ROAD SUBDIVISION
3090 BROWNS VALLEY ROAD
NAPA, CALIFORNIA 94558

Prepared for:

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Project #4121028.0

December 23, 2021



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- 3. Provision E.12 Sizing Calculator Spreadsheet

I. Project Data

Table 1. Project Data Form

Project Name/Number	Browns Valley Road Subdivision / 4121028.0
Application Submittal Date	December 23, 2021
Project Location	3090 Browns Valley Road Napa, California 94558 APN: 041-170-009
Project Phase No.	Not Applicable
Project Type and Description	Construction of an 11-lot single family residential subdivision including streets, driveways, utilities bioretention facilities and a detention facility.
Total Project Site Area	3.8 acres
Total New and Replaced Impervious Surface Area	70,160 sq. ft (including Browns Valley Road frontage improvements)
Total Pre-Project Impervious Surface Area	24,400 sq. ft
Total Post-Project Impervious Surface Area	70,160 sq. ft (including Browns Valley Road new frontage improvements)

II. Setting

II.A. Project Location and Description

This project involves the demolition of an existing residential house and 5 outbuildings with asphalt driveway. The site will be developed into an 11-lot single-family residential subdivision with a public road. This development is located at 3090 Browns Valley Road in Napa, California as shown in Figure 1 below.

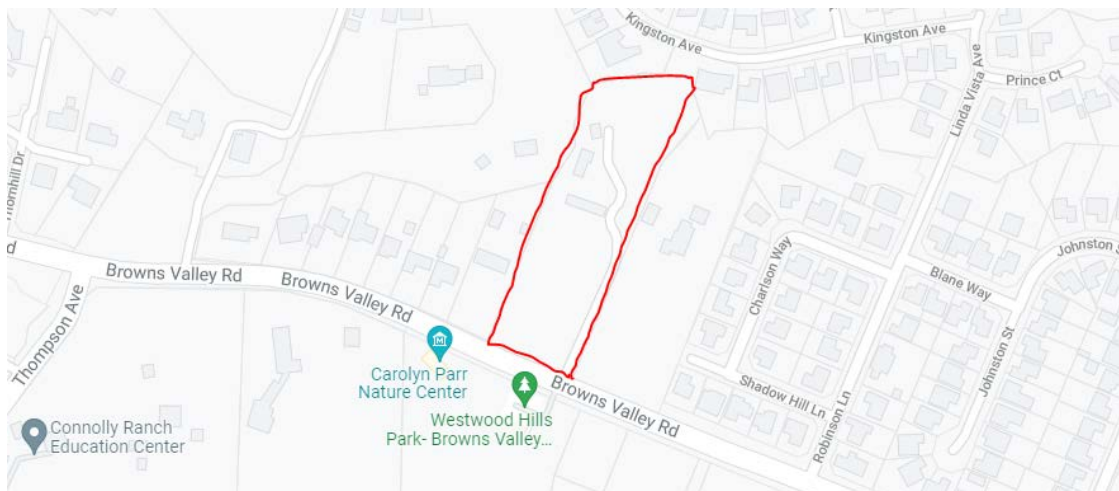


Figure 1. Vicinity Map

The proposed use is consistent with the current RS 10 zoning. The project will include the construction of 11 residential houses, a public road, and installation of new public utilities along with stormwater quality control bioretention and detention facilities.

Refer to Attachment 2 for the overall scope of the project.

II.B. Existing Site Features and Conditions

The project site is irregular in shape, with elevations varying from approximately 90 at Browns Valley Road to 96 at the house and outbuildings to approximately 83 at the northeast corner. Browns Valley Creek slopes down steeply about 15 to 20 feet to the bottom.

The site is currently used for a residential house and outbuildings that fronts Browns Valley Road. The site is bounded by Browns Valley Road to the south, Browns Valley Creek to the north, and residential houses to the east and west. See Figure 2 below for existing site conditions.



Figure 2. Existing Site Conditions

Mapping by the U.S. Conservation Service has classified soil within this project area as 1) Bale Clay Loam (104) which is of the Hydraulic Soil Group B; 2) Cole Silt Loam (118) which is of the Hydraulic Soil Group C, and; 3) Millsholm Loam which is of the Hydraulic Soil Group D. Refer to Attachment 1 for Soils Map. The northern portion of the site drains to Browns Valley Creek at the northern limit of the project, while the southern portion drains towards Browns Valley Road to a public storm drain system that outfalls to Browns Valley Creek along Robinson Lane approximately 600 feet to the east. Stormwater is ultimately conveyed to the Napa River.



II.C. Opportunities and Constraints for Stormwater Control

Stormwater treatment facilities have been integrated into the planning, design, construction, operation, and maintenance of the proposed development. The following potential opportunities and constraints were considered in determining the best stormwater control design for this development.

Opportunities for this site are the availability of landscaped areas in the yards and adjacent to the cul-de-sac. Landscape areas on the backyards of the lots along Browns Valley Creek will be self-treating since they will be predominantly pervious areas. Bioretention facilities will be installed to treat stormwater runoff prior to discharge from the site. Runoff will be conveyed to the bioretention facilities from roof downspouts, and surface flows from the streets. Once in the bioretention basin, runoff will be treated via infiltration together with the pollutant retention capabilities of the plants in the facilities. Treated water from these bioretention facilities will be piped to a detention facility such that the proposed post-developed flow discharge from the development will be maintained at, or below pre-developed levels that will outfall to Browns Valley Creek. See Attachment 2 for locations of bioretention facilities.

Constraints for this site includes the parcel shape, topography, and creek setbacks.

III. Low Impact Development Design Strategies

III.A. Optimization of Site Layout

1. Limitation of development envelope
The development of the houses will occur within the building setback lines per Section 17.08.030 of the City of Napa Municipal Code.
2. Preservation of natural drainage features
Natural drainage consists of sheet flow over the ground surface that concentrates in man-made surface drainage elements such as ditches, gutters, and onsite storm drain pipes. See constraints on Section II.C above.
3. Setbacks from creeks, wetlands, and riparian habitats
The development will comply with structural creek setbacks and preserve riparian habitat along Browns Valley Creek as required by City of Napa Municipal Code.
4. Minimization of imperviousness
Landscaping will be used in the front and rear yards. Impervious areas will be minimized to the maximum extent practicable.
5. Use of drainage as a design element
Bioretention facilities are incorporated into the aesthetic landscape design of the site. Grading and storm drain locations have been designed to direct runoff to bioretention facilities.

III.B. Use of Permeable Pavements

Permeable pavements are not in the scope of this project.

III.C. Dispersal of Runoff to Pervious Areas

Stormwater runoff will be directed to landscaped areas.

III.D. Stormwater Control Measures

Runoff from the project site, including roof and paved areas, will be routed to two bioretention facilities (see Attachment 2). All facilities are designed and will be constructed to the criteria in the BASMAA Post-Construction Manual (January 2019), including the following features (see Figure 3):

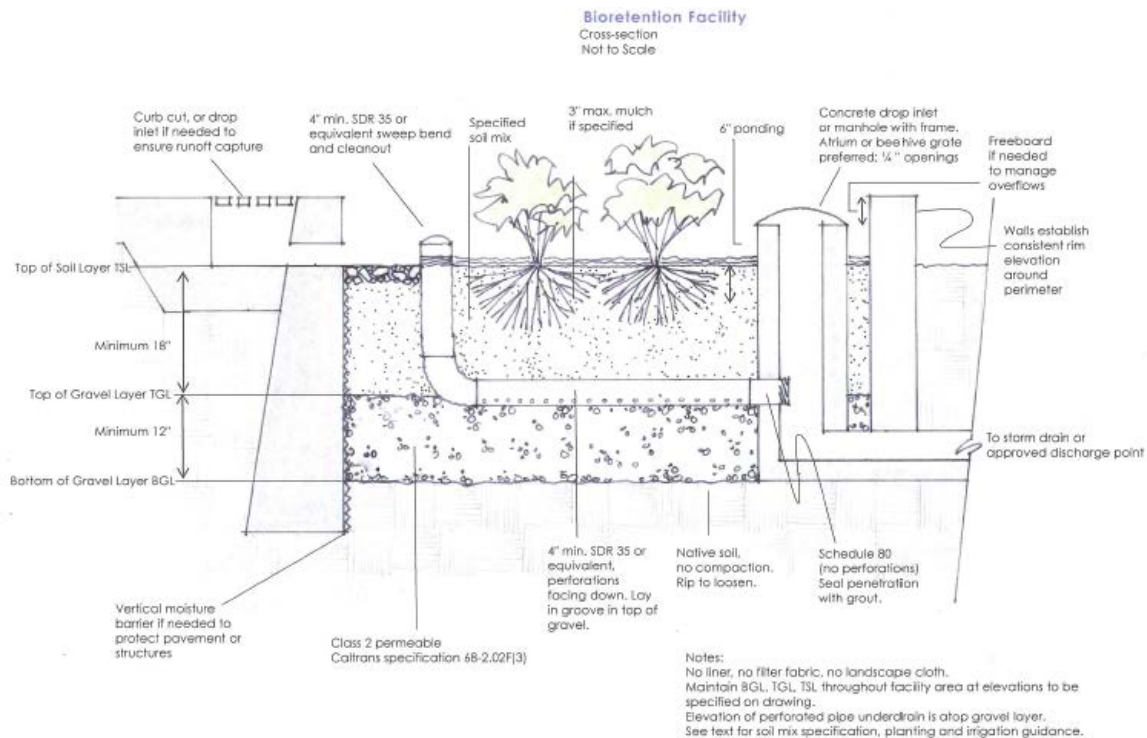


Figure 3. Bioretention Cross Section

- Each layer built flat, level, and to elevations specified in the plans:
 - Bottom of Gravel Layer (BGL)
 - Top of Gravel Layer (TGL)
 - Top of Soil Layer (TSL)
 - Overflow Grate
 - Facility Rim
- 12 inches of Class 2 permeable, Caltrans specification 68-2.02F (3).
- 18 inches sand/compost mix meeting BASMAA specifications.
- 4-inch diameter PVC SDR 35 perforated pipe underdrain, installed with the invert at the top of the Class 2 permeable layer with holes facing down, and connected to the overflow structure at that same elevation.
- 6-inch-deep reservoir between top of soil elevation and overflow grate elevation.



- Concrete drop inlet with frame overflow structure, with grate set to specified elevation, connected to the on-site storm drain system.
- Plantings selected for water conservation.
- Irrigation system on a separate zone, with drip emitters and “smart” irrigation controllers.
- Sign identifying the facility as a stormwater treatment facility.

Areas on the site that do not drain to a bioretention facility are the following (see Attachment 2 for reference):

- DMA 3 – The north half street area of Browns Valley Road along the lots 1 and 11, totaling 11,496 square feet. Grading in this areas must conform with existing street elevations. Existing storm drain facilities on the opposite side of Browns Valley Road are shallow and do not allow for a feasible collection. As a result, stormwater runoff from this DMA leaves the site untreated.
- DMA 4 – The backyards of the lots 5, 6 and 7 and small portions on the backyard of lot 4 totaling 12,640 square feet. This DMA is considered as self-treating area (See Section 4.1 for BASMAA requirements for self-treating areas).

The bioretention facilities that will collect and treat onsite stormwater will also function as Multi-Benefit Trash Treatment Systems in accordance with the State Water Board standards. They are designed to trap trash particles that are 5-mm and greater for the peak flow rate generated by the 1-year, 1-hour storm event from each drainage management area. The bioretention facilities will provide a 6” ponding reservoir per BASMAA requirements, which is sufficient depth such that the 1-year, 1-hour storm event will not reach the overflow elevations. Thus, all trash is captured at the surface of each bioretention facility. The overflow inlets have a grated lid for larger storm events.

IV. Documentation of Drainage Design

IV.A. Descriptions of Each Drainage Management Areas

IV.A.1. Drainage Management Areas

Table 2. Drainage Management Areas (DMAs) as shown on Attachment 2.

DMA Name	DMA perv (Pervious Area, square feet)	DMA imp (Impervious Area, square feet)	Pervious Pavers Area (square feet)	Total Area (square feet)	Bioretention Facility Name
1	48,613	57,603	--	108,732	BA #1
2	3,938	4,947	--	9,115	BA #2
3	3,889	7,607	--	11,496	Untreated
4	12,640	0	--	12,640	Self-Treating



IV.A.2. Drainage Management Area Descriptions

DMA 1: Totaling 108,732 square feet, this DMA consists of Lots 2, 3, 8 to 10 and portions of Lots 1, 4, 5, 7, and 11. It also includes the majority of Street A. Runoff from the roofs will drain out from downspouts to splash boxes that flows towards the street via landscape areas then along the street gutter toward a curb opening inlet that outfalls to BA #1. This bioretention facility has a total treatment area of 2,516 square feet.

DMA 2: Totaling 9,115 square feet, this DMA consists of portions of Lots 6. Runoff from the roof will drain out from downspouts to splash boxes that flows towards BA #2. This bioretention facility has a total treatment area of 230 square feet.

DMA 3: Totaling 11,496 square feet, this DMA consists of portions of Lots 1 and 11 side yards, a small portion of Street A, and widening of Browns Valley Road along the project frontage. Grading in this area must conform with existing street elevations. Existing storm drain facilities on the opposite side of Browns Valley Road are shallow and do not allow for a feasible collection. As a result, stormwater runoff from this DMA leaves the site untreated.

DMA 4: Totaling 12, 640 square feet, this DMA consists of portions of Lots 4 to 7. This DMA is considered as self-treating area meeting the following BASMAA requirements: 1) There are no impervious areas or very small impervious area (5% or less) relative to the receiving pervious area; and 2) Slopes are gentle enough to ensure runoff will be absorbed into the vegetation and soil.

IV.B. Tabulation and Sizing Calculations

Refer to Attachment 3 for Provision E.12 Sizing Calculator Spreadsheet.

V. Source Control Measures

V.A. Site activities and potential sources of pollutants

On-site activities that could potentially produce stormwater pollutants are listed in Table 3 below:

V.B. Potential Pollutant Sources and Source Control Measures

The site activities and potential sources of pollutants for the Browns Valley Road Subdivision project are listed in Table 3, below.

Table 3. Potential Pollutant Sources and Source Control Measures

Potential Sources of Runoff Pollutants	Permanent Source Control BMPs	Operational Source Control BMPs
A. On-site storm drain inlets (unauthorized non-stormwater discharges and accidental spills or leaks)	☐ Mark all inlets with the words "No Dumping! Flows to River" or similar.	☐ Maintain and periodically repaint or replace inlet markings. ☐ Provide stormwater pollution prevention information to new site owners, lessees, or operators. ☐ See applicable operational BMPs in Fact Sheet SC-74, "Drainage System Maintenance."



Potential Sources of Runoff Pollutants	Permanent Source Control BMPs	Operational Source Control BMPs
D ₁ . Need for future indoor & structural pest control	☐ Building design shall incorporate features that discourage entry of pests.	☐ Provide Integrated Pest Management information to owners, lessees, and operators.
D ₂ . Landscape / outdoor pesticide use / building and grounds maintenance	Final landscape plans will accomplish all of the following: ☐ Preserve existing native trees, shrubs, and ground cover to the maximum extent possible. ☐ Minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution. ☐ Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions. ☐ Use pest-resistant plants, especially adjacent to hardscape. ☐ To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.	☐ Maintain landscaping using minimum or no pesticides. ☐ See applicable operational BMPs in Fact Sheet SC-41, "Building and Grounds Maintenance." ☐ Provide IPM information to new owners, lessees and operators.
O. Miscellaneous drain or wash water or other sources • Boiler drain lines • Condensate drain lines • Rooftop equipment • Drainage sumps • Roofing, gutters, and trim • Other sources	☐ Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain. ☐ Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system. ☐ Rooftop equipment with potential to produce pollutants shall be roofed and/or have secondary containment. ☐ Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water.	If architectural copper is used, implement the following BMPs for management of rinse water during installation: ☐ If possible, purchase copper materials that have been pre-patinated at the factory. ☐ If patination is done on-site, prevent rinse water from entering storm drains by discharging to landscaping or by collecting in a tank and hauling off-site. ☐ Consider coating the copper materials with an impervious coating that prevents further corrosion and runoff. ☐ Implement the following BMPs during routine maintenance: ☐ Prevent rinse water from entering storm drains by discharging to landscaping or by collecting in a tank and hauling off-site.



VI. Stormwater Facility Maintenance

VI.A. Ownership and Responsibility for Maintenance in Perpetuity

Maintenance of stormwater facilities will be the responsibility of the property owner and will be performed by the owner's contractors or employees as part of routine maintenance of buildings, grounds and landscaping. The applicant will review the Post-Construction BMP Maintenance Agreement with the City of Napa regarding the maintenance of the stormwater facilities and commit to execute any necessary agreements prior to completion of construction. Applicant accepts responsibility for interim operation and maintenance of stormwater treatment and flow-control facilities until such time as this responsibility is formally transferred to a subsequent owner.

VI.B. Summary of Maintenance Requirements for Each Stormwater Facility

The bioretention facilities will be maintained on the following schedule at a minimum. Details of maintenance responsibility and procedures will be included in an Operation and Maintenance Plan to be submitted for approval prior to the completion of construction.

At no time will synthetic pesticides or fertilizers be applied, nor will any soil amendments, other than aged compost mulch or sand/compost mix, be introduced.

Daily: The facilities will be examined for visible trash during regular policing of the site, and trash will be removed.

After Significant Rain Events: A significant rain event is one that produces approximately a half-inch or more rainfall in a 24-hour period. Within 24 hours after each such event, the following will be conducted:

- The surface of the facility will be observed to confirm there is no excessive ponding. All facilities are designed to pond up to a 6" reservoir for stormwater treatment.
- Inlets will be inspected, and any accumulations of trash or debris will be removed.
- The surface of the mulch layer will be inspected for movement of material. Mulch will be replaced and raked smooth if needed.

Prior to the Start of the Rainy Season: In September of each year, the facility will be inspected to confirm there is no accumulation of debris that would block flow, and that growth and spread of plantings does not block inlets or the movement of runoff across the surface of the facility.

Annual Landscape Maintenance: In December – February of each year, vegetation will be cut back as needed, debris removed, and plants and mulch replaced as needed. The concrete work will be inspected for damage. The elevation of the top of soil and mulch layer will be confirmed to be consistent with the 6-inch reservoir depth.



VII. Construction Plan E.12 Checklist

Table 4. Construction Plan E.12 Checklist

Stormwater Control Plan Page #	Source Control or Treatment Control Measure	See Plan
1	Bioretention Facilities	SCP Site Plan in Attachment 2

VIII. Certifications

The preliminary design of stormwater treatment facilities and other stormwater pollution control measures in this plan are in accordance with the current edition of the BASMAA Post-Construction Manual, dated January 2019.

A handwritten signature in black ink, appearing to read "Derek Dittman", is positioned above a horizontal line.

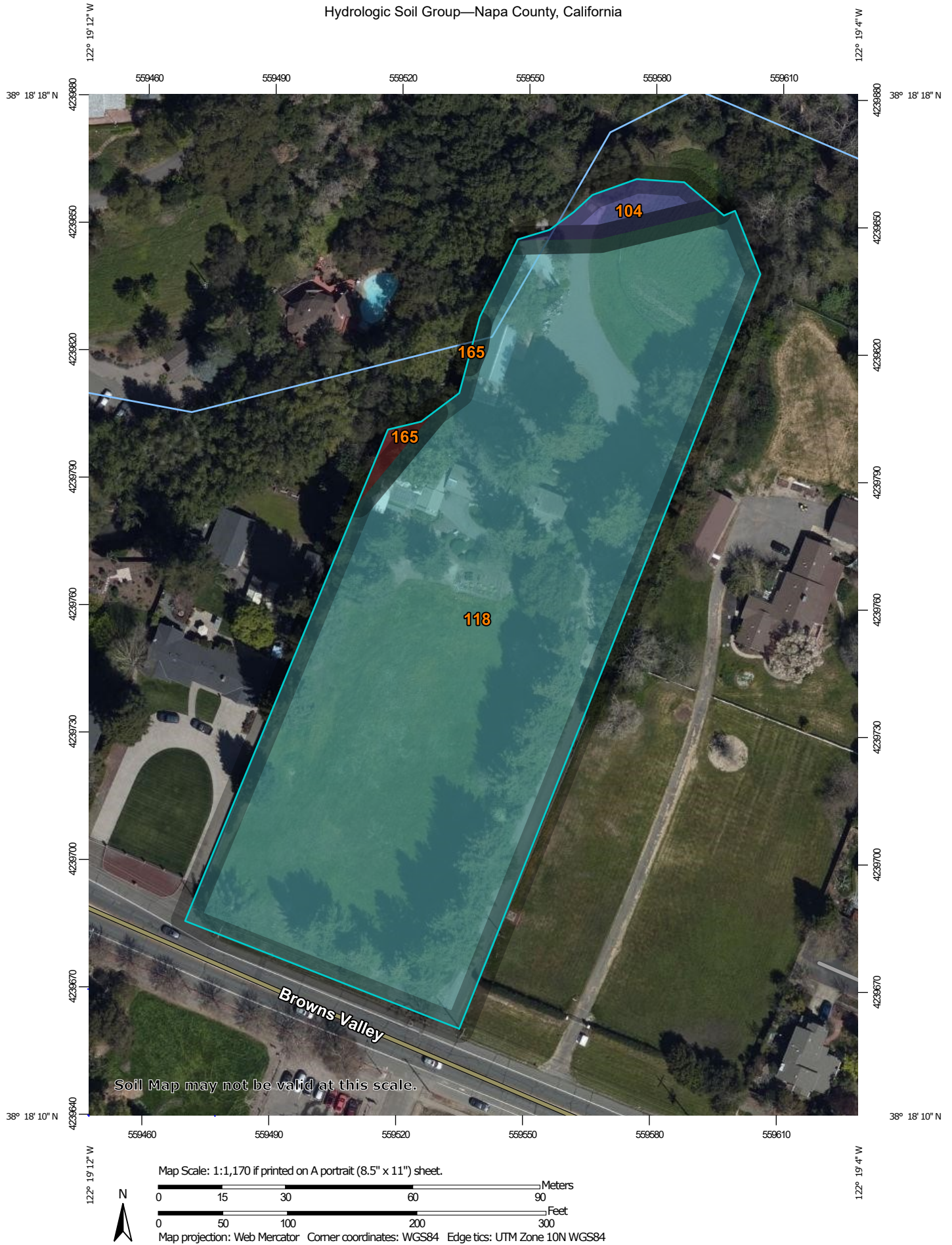
Preparer
Derek Dittman, PE



ATTACHMENT 1

SOIL CLASSIFICATION

Hydrologic Soil Group—Napa County, California



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 1:24,000.

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: Napa County, California
Survey Area Data: Version 14, Sep 9, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 15, 2019—Apr 10, 2019

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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
104	Bale clay loam, 0 to 2 percent slopes	B	0.1	2.7%
118	Cole silt loam, 0 to 2 percent slopes, MLRA 14	C	3.1	96.7%
165	Millsholm loam, 6 to 55 percent slopes, MLRA 15	D	0.0	0.6%
Totals for Area of Interest			3.2	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.

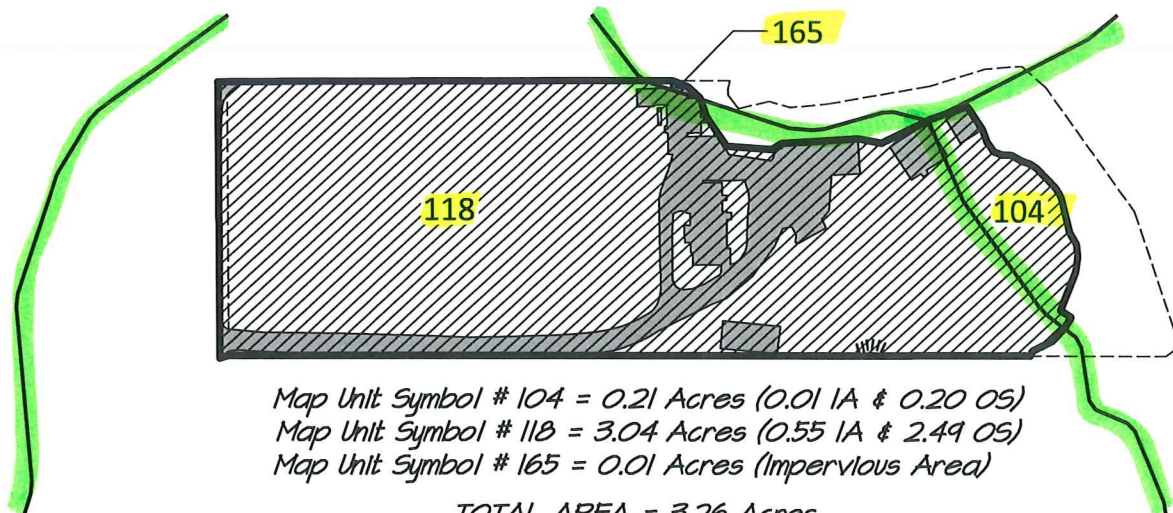
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

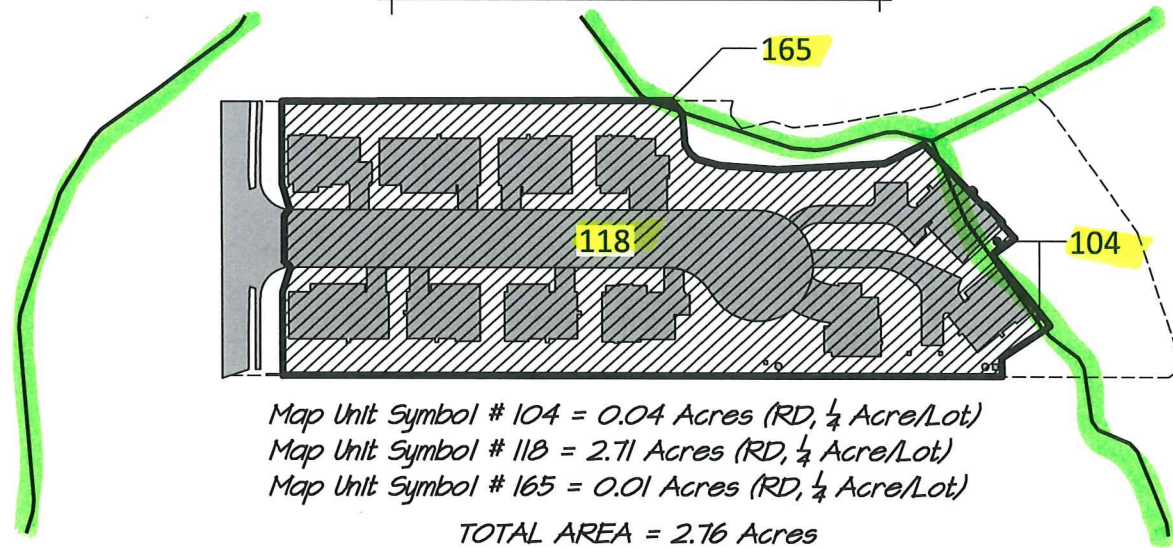
Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over 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.

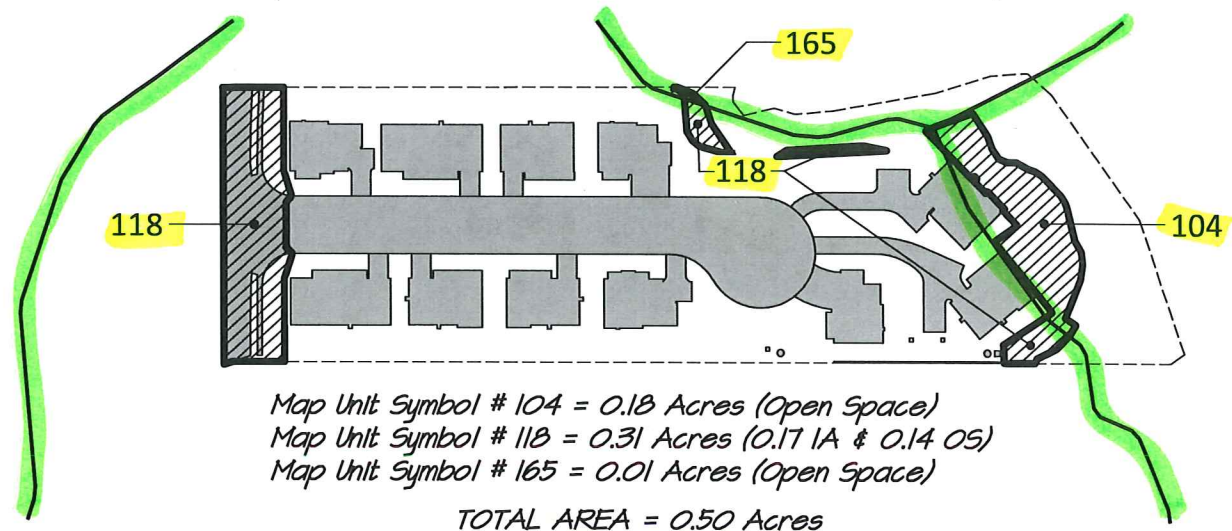
HYDROLOGIC SOIL GROUP EXHIBIT



EXISTING WATERSHED



PROPOSED DETAINED WATERSHED

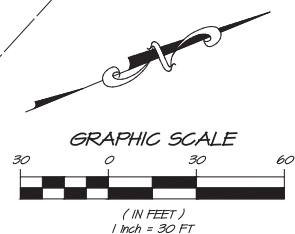


PROPOSED UNDETAINED WATERSHED



ATTACHMENT 2

STORMWATER CONTROL PLAN (SHEET TM6)



PRELIMINARY - NOT FOR CONSTRUCTION



ATTACHMENT 3

PROVISION E.12 SIZING CALCULATOR SPREADSHEET

Provision E.12 Sizing Calculator

See the instructions and the BASMAA Post-Construction Manual

Step 1: Enter Total Site Area	Step 2: List names of all DMAs and square footage of each	Step 3: If DMA is "Self-Treating" or "Self-Retaining," copy square footage to appropriate column	Step 4: If the DMA is "Drains to Self Retaining" or "Drains to Bioretention" enter runoff factor from Table 4-1		Step 6: For "Drains to Self-Retaining" DMAs, enter the name of receiving DMA	Step 5: Slide (move) number from this column to correct column (F or H-Q)								
Total Site Area:	141,983						BIORETENTION FACILITIES							
		Self-Treating	Self-Retaining			Name of Receiving DMA								
DMA Names	Square Feet			Runoff Factor	Untreated		BA #1	BA #2						
DMA-1 _{perv}	48,613			0.1			4,861							
DMA-1 _{imp}	57,603			1			57,603							
DMA-2 _{perv}	3,938			0.1				394						
DMA-2 _{imp}	4,947			1				4,947						
DMA-3 _{perv}	3,889				3,889									
DMA-3 _{imp}	7,607				7,607									
DMA-4 _{perv}	12,640	12,640												
DMA-4 _{imp}	0	0												
Total DMAs	139,237	12,640	0		11,496		62,464	5,341	0	0	0	0	0	0
							Sizing Factor	0.04	0.04	0.04	0.04	0.04	0.04	0.04
							Minimum Size	2,499	214	0	0	0	0	0
Total Facilities	2,746	Step 7: Enter Facility Footprints				Footprint on Exhibit	2,516	230	0	0	0	0	0	0
DMAs + Facilities	141,983	OK OK OK OK OK OK OK OK												
		OK	Step 8: Iterate sizes of facility footprints and DMAs until all footprints are at least the minimum AND DMAs + Facilities equals Total Site Area Step 9: Check to make sure Areas Draining to each Receiving Self-Retaining Area do not exceed maximum 2:1 ratio. Step 10: Check results on this spreadsheet are consistent with what is shown on the SCP Exhibit.											

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F.2 - Preliminary Detention Calculations

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PRELIMINARY DETENTION CALCULATIONS

BROWNS VALLEY ROAD SUBDIVISION
3090 BROWNS VALLEY ROAD
NAPA, CALIFORNIA 94558

Prepared for:

EDENBRIDGE HOMES

Project #4121028.0

December 23, 2021



Table of Contents

Executive Summary

Introduction
Existing Conditions
Proposed Conditions

Appendix A: Watershed Exhibits

Existing Watershed Exhibit
Proposed Detained Watershed Exhibit
Proposed Undetained Watershed Exhibit

Appendix B: Hydrograph Calculation Parameters

Hydrologic Soil Group, Web Soil Survey (4 Sheets)
Runoff Curve Number Table, TR 55 (Table 2-2a)
Runoff Curve Number Calculations (3 Sheets)
Table 3-1, TR 55 (Roughness Coefficients for Sheet Flow)
Table 2.2, City of Napa Drainage Standards (Rainfall Depth – Duration)
Time of Concentration Calculations (7 Sheets)

Appendix C: Detention Calculations using Hydraflow

Watershed Model Schematic
Hydrograph Return Period Recap
10 -Year Report
 Hydrograph Summary Report
 Existing Watershed Hydrograph
 Proposed Pre-Routed Watershed Hydrograph
 Proposed Undetained Watershed Hydrograph
 Proposed Detained/Routed Hydrograph
Pond Report
IDF Report
Conclusion



INTRODUCTION

In order to satisfy the City of Napa Drainage Design Standard Section 2.10.02, which states that projects must provide detention of stormwater such that peak flows do not exceed pre-developed runoff rates, the TR-55 method was used to demonstrate the peak runoff rates of the site in both the pre- and post-developed conditions. This calculation was then used to determine the on-site storage volume necessary to limit post-development rates below the pre-developed conditions. Because the project site is in the Browns Valley Basin and proposes more than 4 residential units, it is required to detain up to the 10-year design storm. Based on this calculation, as summarized in the Conclusion in Appendix C, the site has adequate storage capacity in the detention facility to detain the post-development peak flows as required.

The method used for this calculation is hydrograph analysis. The unit hydrograph rainfall distribution for the City of Napa falls under Type IA-distribution. The SCS hydrograph analysis is based on the National Resources Conservation Service Technical Release 55 for Urban Hydrology for Small Watersheds (TR-55) method (refer to Appendix B for Hydrograph Calculation Parameters).

There is only one watershed considered in this calculation.

EXISTING CONDITIONS

The northern portion of the site currently drains to Browns Valley Creek at the northern limit of the project while the southern portion drains towards Browns Valley Road to a public storm drain system that outfalls to Browns Valley Creek along Robinson Lane approximately 600 feet to the east. This existing outfall will be used as the point of convergence for all time of concentration calculations. An exhibit showing the existing watershed area and time of concentration flow summary can be found in Appendix A.

PROPOSED CONDITIONS

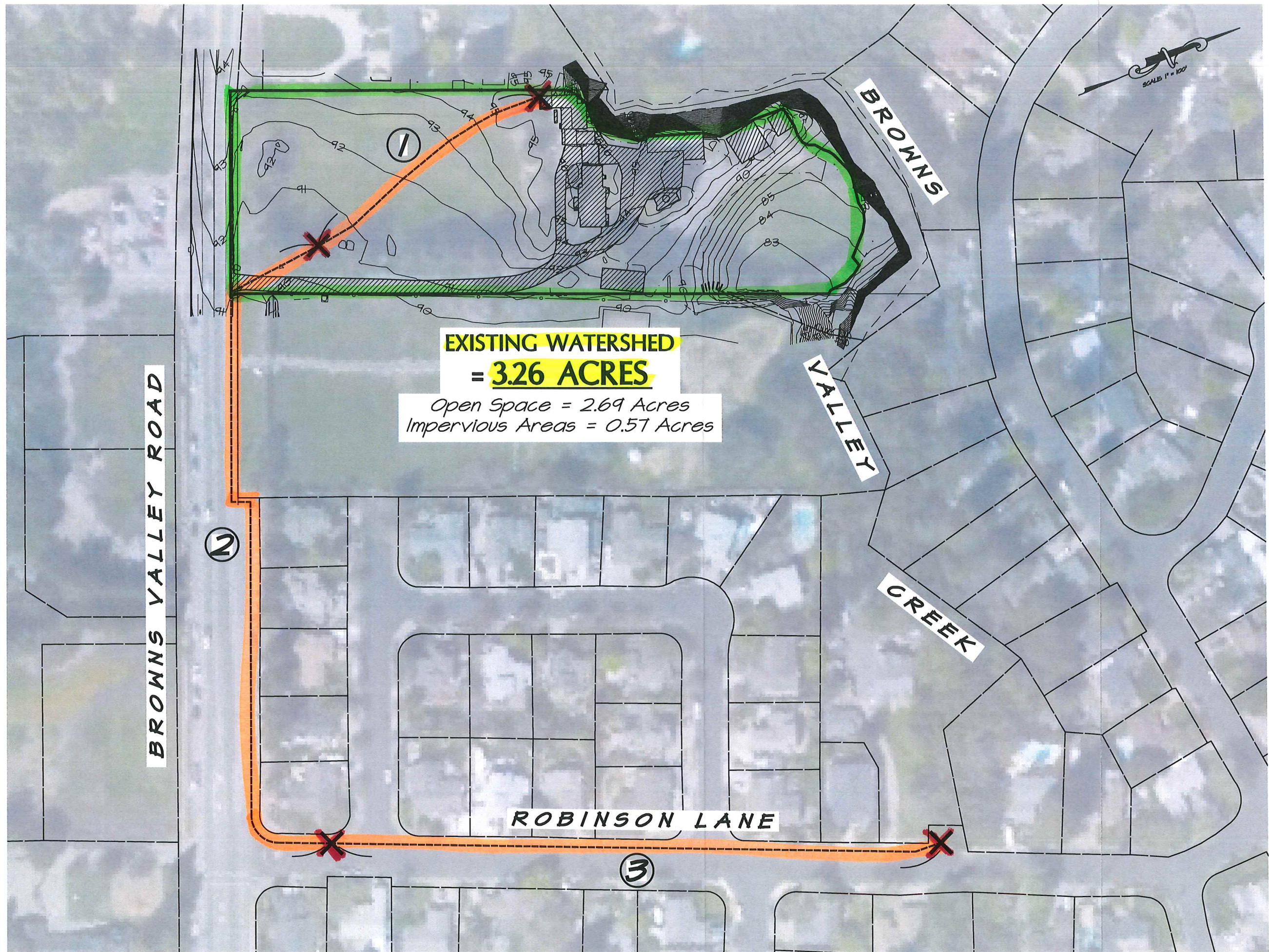
A detention facility will be provided to detain runoff and mitigate peak flows. Portions of the developed site are not feasible to be captured and detained, including the new frontage along Browns Valley Road and the backyards of Lots 5 and 6. Therefore, the site watershed will have portions that will be detained and portions that will not be detained. Total post-development flow was calculated by summing the detained and undetained portions for comparison with pre-development conditions using the terminus of Browns Valley Creek at Robinson Lane.

Refer to Appendix A for Watershed Exhibits of the proposed detained and undetained watershed areas and time of concentration flow summaries. The proposed runoff for the 10-year storm is shown in the Conclusion (refer to Appendix C for Detention Calculation using Hydraflow Hydrographs Extension).



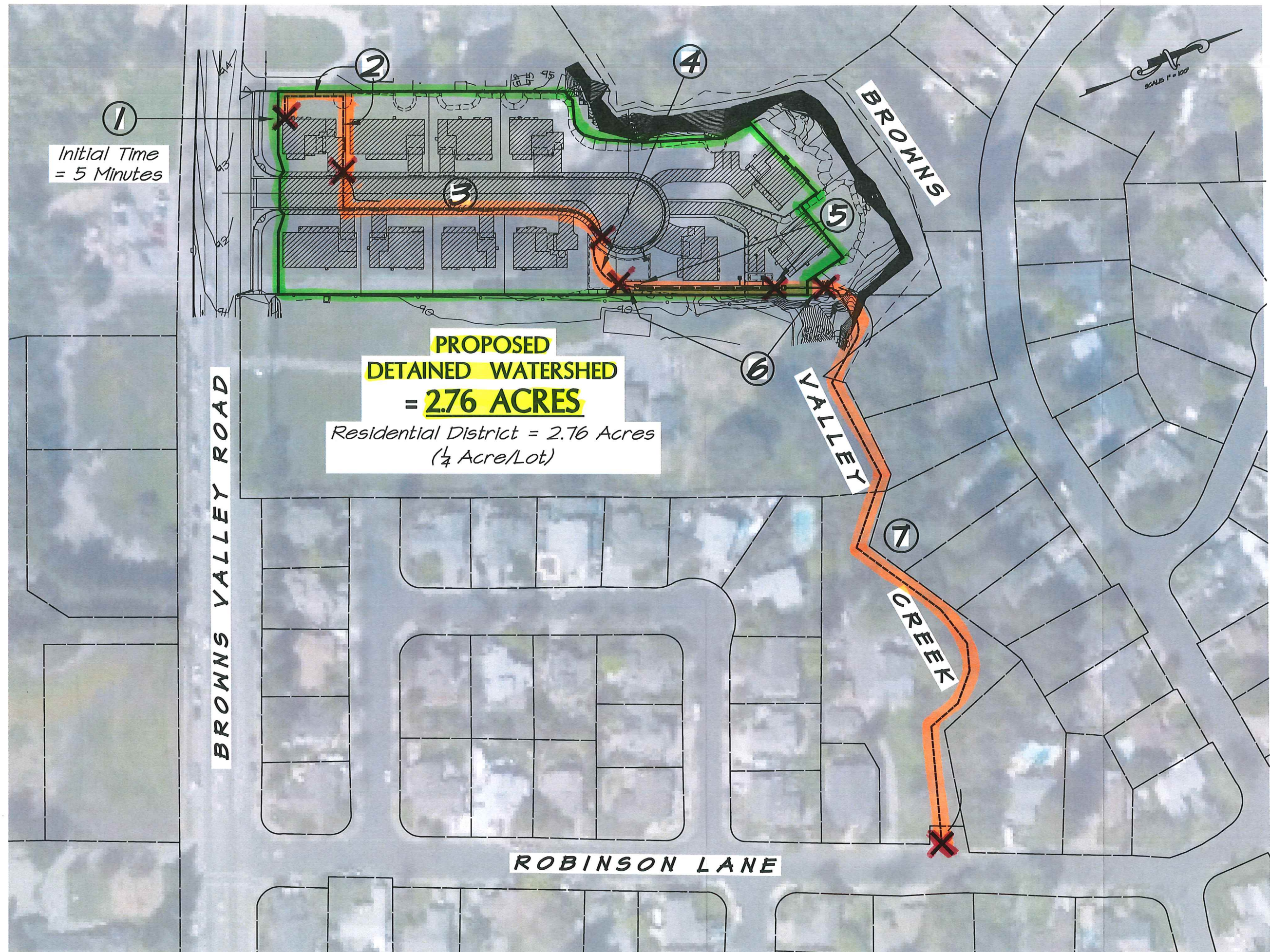
APPENDIX A

WATERSHED EXHIBITS



Time of Concentration Flow Table				
SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
①	SHEET FLOW	SHORT GRASS	300	0.015
②	SHALLOW FLOW	UNPAVED	820	0.02
③	CHANNEL FLOW	36" RCP SD	680	0.006

EXISTING WATERSHED EXHIBIT
FOR PRELIMINARY
DETENTION SYSTEM CALCULATION



Time of Concentration Flow Table				
SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
INITIAL TIME = 5 MINUTES				
①	SHALLOW FLOW	UNPAVED	175	0.011
②	SHALLOW FLOW	PAVED	340	0.006
③	SHALLOW FLOW	UNPAVED	60	0.005
④	SHALLOW FLOW	UNPAVED	150	0.003
⑤	CHANNEL FLOW	48" RCP SD	55	0.006
⑥	CHANNEL FLOW	18" RCP SD	130	0.035
⑦	SHALLOW FLOW	UNPAVED		

PROPOSED DETAINED WATERSHED
EXHIBIT FOR PRELIMINARY
DETENTION SYSTEM CALCULATION



Time of Concentration Flow Table				
SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
①	SHEET FLOW	COMBINATION*	300	SEE BELOW
②	SHALLOW FLOW	UNPAVED	675	0.02
③	CHANNEL FLOW	36" RCP SD	680	0.006

* COMBINATION OF: SHORT GRASS (15' AT S= 0.017)
PAVED SURFACE (225' AT S= 0.011)

PROPOSED UNDETAINED WATERSHED
EXHIBIT FOR PRELIMINARY
DETENTION SYSTEM CALCULATION



APPENDIX B

HYDROGRAPH CALCULATION PARAMETERS

Hydrologic Soil Group—Napa County, California



Soil Map may not be valid at this scale.

Map Scale: 1:1,170 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

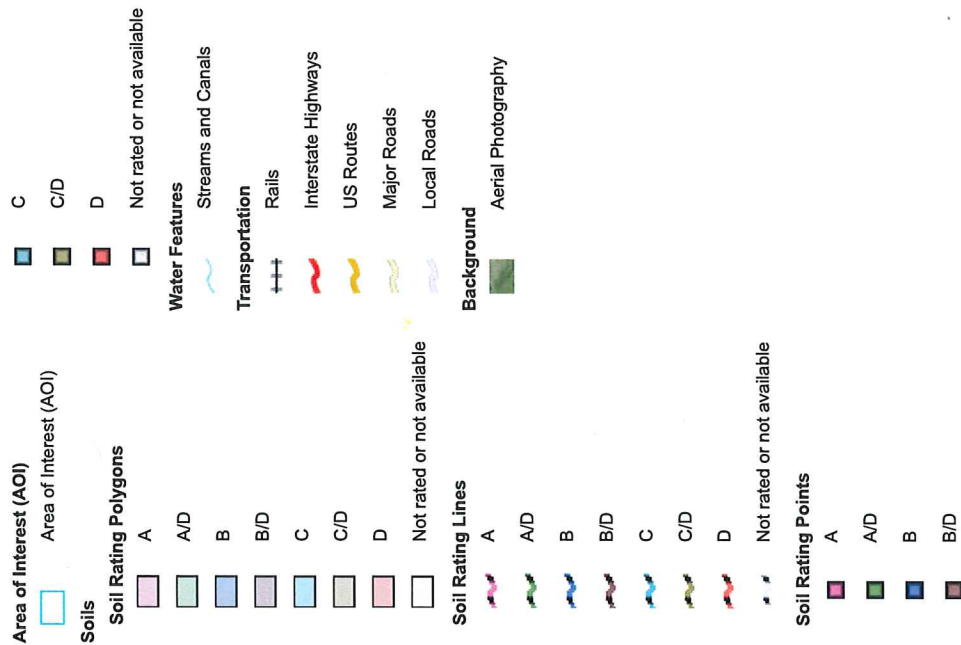


Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

12/2/2021
Page 1 of 4

MAP LEGEND



MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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: Napa County, California
Survey Area Data: Version 14, Sep 9, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 15, 2019—Apr 10, 2019

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

~~SEE~~ HYDROLOGIC SOIL GROUP EXHIBIT NEXT PAGE

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
104	Bale clay loam, 0 to 2 percent slopes	B	0.1	2.7%
118	Cole silt loam, 0 to 2 percent slopes, MLRA 14	C	3.1	96.7%
165	Millsholm loam, 6 to 55 percent slopes, MLRA 15	D	0.0	0.6%
Totals for Area of Interest			3.2	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.

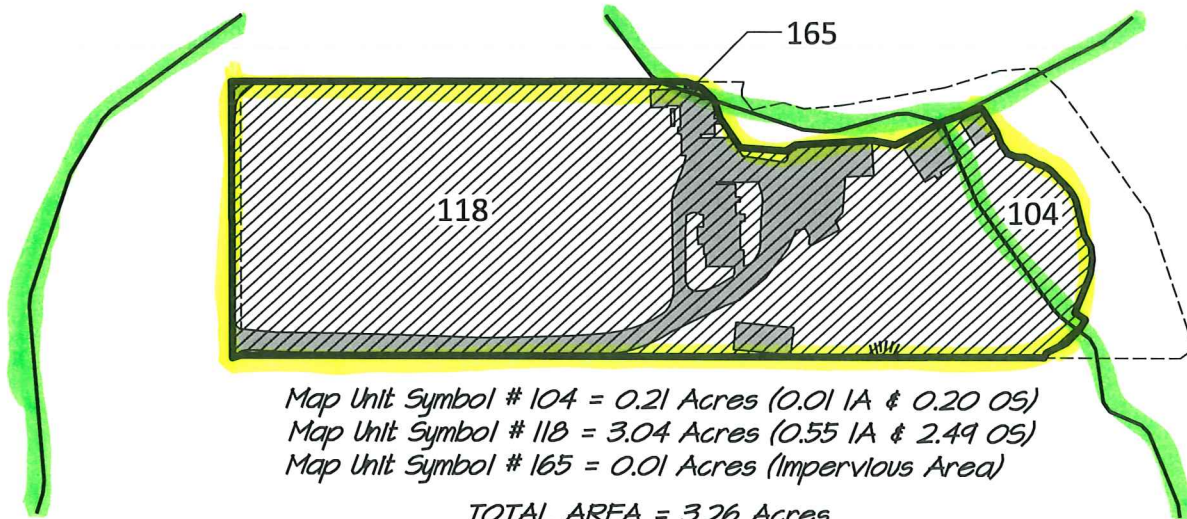
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

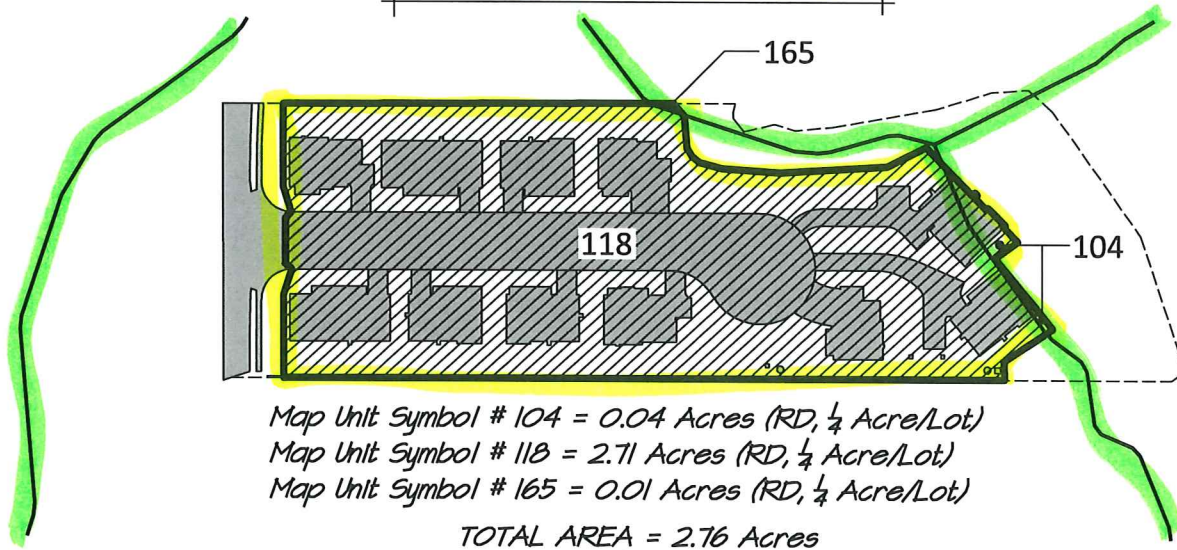
Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over 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.

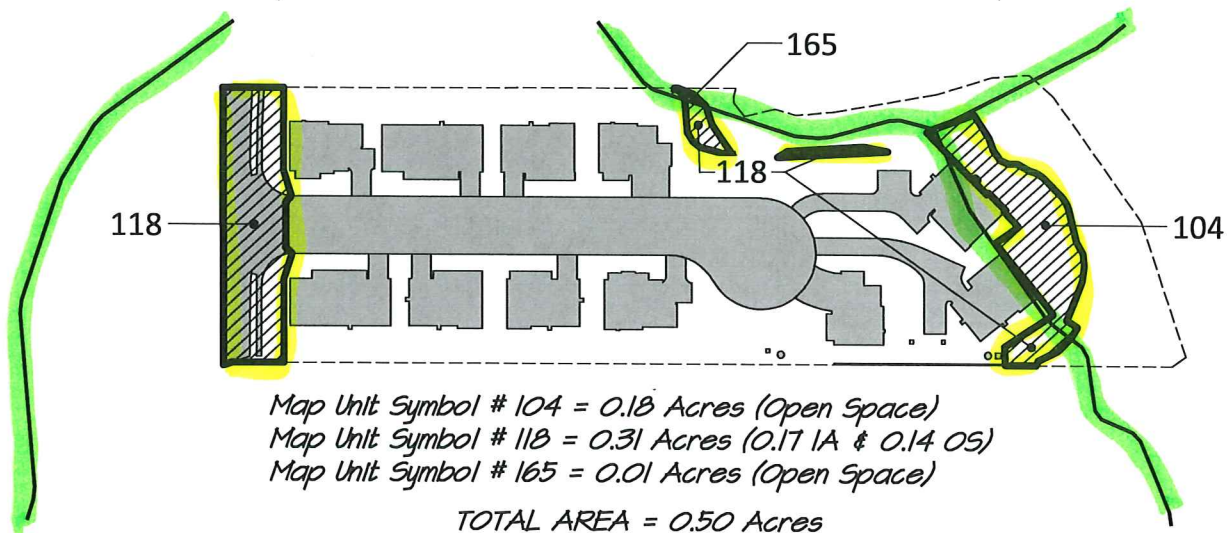
HYDROLOGIC SOIL GROUP EXHIBIT



EXISTING WATERSHED



PROPOSED DETAINED WATERSHED



PROPOSED UNDETAINED WATERSHED

Table 2-2a Runoff curve numbers for urban areas ^{1/}

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area ^{2/}	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) ^{3/}:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ^{4/}		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas					
(pervious areas only, no vegetation) ^{5/}		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

^{1/} Average runoff condition, and $I_a = 0.2S$.^{2/} The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.^{3/} CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.^{4/} Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.^{5/} Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.**TABLE 2-2a (TR 55)**

Worksheet: Runoff Curve Number

Project	Browns Valley Road Subdivision	By	Ray	Date	12/23/2021
Location	Napa, California	Checked		Date	
Subshed name	Existing Watershed	Check one: ☒ Present ☐ Developed			

RUNOFF CURVE NUMBER

Soil name and hydrologic group (SCS book)	Cover description (cover type, treatment and hydrogic condition; percent impervious)	CN (1) (Table 2-2)	Area	Product of CN x Area
			☒ acres ☐ mi2 ☐ %	
104-B	Open Space (Grass Cover, Good Condition)	61	0.20	12.20
104-B	Impervious Areas (Paved Areas & Roofs)	98	0.01	0.98
118-C	Open Space (Grass Cover, Good Condition)	74	2.49	184.26
118-C	Impervious Areas (Paved Areas & Roofs)	98	0.55	53.90
165-D	Impervious Areas (Paved Areas & Roofs)	98	0.01	0.98
(1) Use only one CN source per line			TOTAL:	3.26
				252.32

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{252.32}{3.26} = 77.40 \quad ; \quad \text{USE CN}$$

77

Worksheet: Runoff Curve Number

Project	Browns Valley Road Subdivision	By	Ray	Date	12/23/2021
Location	Napa, California	Checked		Date	
Subshed name	Proposed Detained Watershed	Check one:	☐ Present	☒ Developed	

RUNOFF CURVE NUMBER

[illegible]

(1) Use only one CN source per line

TOTAL:

2.76

228.80

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{228.80}{2.76} = \frac{82.90}{1} ; \text{ USE CN}$$

83

Worksheet: Runoff Curve Number

Project	Browns Valley Road Subdivision	By	Ray	Date	12/23/2021
Location	Napa, California	Checked		Date	
Subshed name	Proposed Undetained Watershed	Check one:	☐ Present ☒ Developed		

RUNOFF CURVE NUMBER[illegible]

(1) Use only one CN source per line

TOTAL:

0.50

38.80

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{38.80}{0.50} = \frac{77.60}{1.00} ; \text{ USE CN}$$

78

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n 1/
→ Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
→ Grass:	
Short grass prairie	0.15
Dense grasses 2/	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods: 3/	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).

2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

3 When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t :

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \quad [\text{eq. 3-3}]$$

where:

- T_t = travel time (hr),
- n = Manning's roughness coefficient (table 3-1)
- L = flow length (ft)
- P_2 = 2-year, 24-hour rainfall (in)
- s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

TABLE 3-1
ROUGHNESS COEFFICIENTS
FOR SHEET FLOW

FREQUENCY	RAINFALL DEPTH/STORM DURATION, INCHES									
	5 M	15 M	1 HR	2 HR	3 HR	6 HR	12 HR	24 HR	2 D	4 D
2-YR	0.15	0.27	0.57	0.82	1.02	1.50	1.98	2.45	3.12	4.03
5-YR	0.20	0.38	0.80	1.16	1.42	2.12	2.79	3.44	4.51	5.77
10-YR	0.25	0.46	0.97	1.39	1.70	2.53	3.33	4.12	5.42	6.94
25-YR	0.30	0.56	1.16	1.66	2.04	3.03	4.00	4.95	6.63	8.38
50-YR	0.32	0.62	1.30	1.87	2.29	3.40	4.48	5.56	7.49	9.44
100-YR	0.36	0.69	1.44	2.07	2.54	3.76	4.96	6.14	8.33	10.45
500-YR	0.45	0.85	1.78	2.55	3.14	4.67	6.15	7.60	10.50	13.01

CHART IS FROM CITY OF NAPA 2006 STORM DRAINAGE MASTER PLAN TABLE 3-2

CITY OF NAPA

PUBLIC WORKS DEPARTMENT

RAINFALL DEPTH - DURATION

DRAWN BY: BRL

CHECKED BY: TCW

DATE: 05/2018

APPROVED BY: JRL

SCALE: NONE

DRAWING NO.

FIELD NOTES:

TABLE-2.2

Worksheet: Time of Concentration (T_c) or travel time (T_t)

Project	Browns Valley Road Subdivision	By	Ray	Date	12/23/2021
Location	Napa, California	Checked		Date	
Subshed name	Existing Watershed	Check one:	☒ Present	☐ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☒ T _c	☐ T _t through subarea	

SHEET FLOW (applicable to T_c only)

Segment ID	1	
1. Surface description (table 3-1)	Short Grass	
2. Manning's roughness coefficient, n (table 3-1)	0.15	
3. Flow length, L (total L, 300 ft)	300	
4. Two-year 24-hour rainfall, P ₂	2.45	
5. Land slope, s	0.015	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t	0.5043	+
		=
		0.5043

SHALLOW CONCENTRATED FLOW

Segment ID	2	
7. Surface description (paved or unpaved)	Unpaved	
8. Flow length, L	820	
9. Watercourse slope, s	0.02	
10. Average velocity, V (figure 3-1)	2.2818	
11. $T_t = \frac{L}{3600 V}$ Compute T _t	0.0998	+
		=
		0.0998

CHANNEL FLOW

Segment ID	3	
12. Cross sectional flow area, a	7.0686	
13. Wetted perimeter, p _w	9.4248	
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	0.7500	
15. Channel slope, s	0.006	
16. Manning's roughness coefficient, n	0.013	
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	7.3287	
18. Flow length, L	680	
11. $T_t = \frac{L}{3600 V}$ Compute T _t	0.0258	+
		=
		0.0258
20. Watershed or subarea T _c or T _t (add T _t in steps 6, 11 and 19)		0.6299

1 of 4

= 37.8 Minutes

Worksheet: Time of Concentration (T_c) or travel time (T_t)

Project	Browns Valley Road Subdivision	By	Ray	Date	12/23/2021
Location	Napa, California	Checked		Date	
Subshed name	Proposed Detained Watershed (1 of 2)	Check one:	☐ Present	☒ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☒ T _c	☐ T _t through subarea	

SHEET FLOW (applicable to T_c only)

Segment ID	1	
1. Surface description (table 3-1)	Initial Time	5 Minutes
2. Manning's roughness coefficient, n (table 3-1)	0.15	
3. Flow length, L (total L, 300 ft)	33.65	
4. Two-year 24-hour rainfall, P ₂	2.45	
5. Land slope, s	0.017	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t	0.0833	0.0833

SHALLOW CONCENTRATED FLOW

Segment ID	2	3
7. Surface description (paved or unpaved)	Unpaved	Paved
8. Flow length, L	175	340
9. Watercourse slope, s	0.011	0.006
10. Average velocity, V (figure 3-1)	1.6922	1.5746
11. $T_t = \frac{L}{3600 V}$ Compute T _t	0.0287	0.0600

CHANNEL FLOW

Segment ID	5	6
12. Cross sectional flow area, a	12.5664	1.7671
13. Wetted perimeter, p _w	12.5664	4.7124
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	1.0000	0.3750
15. Channel slope, s	0.003	0.006
16. Manning's roughness coefficient, n	0.013	0.013
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V	6.2777	4.6167
18. Flow length, L	150	55
11. $T_t = \frac{L}{3600 V}$ Compute T _t	0.0066	0.0033
20. Watershed or subarea T _c or T _t (add T _t in steps 6, 11 and 19)		0.1820

Worksheet: Time of Concentration (T_c) or travel time (T_t)

Project	Browns Valley Road Subdivision	By	Ray	Date	12/23/2021
Location	Napa, California	Checked		Date	
Subshed name	Proposed Detained Watershed (2 of 2)	Check one:	☐ Present	☒ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☒ T _c	☐ T _t through subarea	

SHEET FLOW (applicable to T_c only)

Segment ID	Time from	
1. Surface description (table 3-1)	1 of 2	
2. Manning's roughness coefficient, n (table 3-1)	0.15	
3. Flow length, L (total L, 300 ft)	48.45	
4. Two-year 24-hour rainfall, P ₂	2.45	
5. Land slope, s	0.005	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t	0.1820	+
		=
		0.1820

SHALLOW CONCENTRATED FLOW

Segment ID	4	7
7. Surface description (paved or unpaved)	Unpaved	Unpaved
8. Flow length, L	60	730
9. Watercourse slope, s	0.005	0.035
10. Average velocity, V (figure 3-1)	1.1409	3.0185
11. $T_t = \frac{L}{3600 V}$ Compute T _t	0.0146	+
		0.0672
		=
		0.0818

CHANNEL FLOW

Segment ID		
12. Cross sectional flow area, a		
13. Wetted perimeter, p _w		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r		
15. Channel slope, s		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V		
18. Flow length, L		
11. $T_t = \frac{L}{3600 V}$ Compute T _t		+
20. Watershed or subarea T _c or T _t (add T _t in steps 6, 11 and 19)		=
		0.2638

3 of 4

= 15.8 Minutes

Worksheet: Time of Concentration (T_c) or travel time (T_t)

Project	Browns Valley Road Subdivision	By	Ray	Date	12/23/2021
Location	Napa, California	Checked		Date	
Subshed name	Proposed Undetained Watershed	Check one:	☒ Present	☐ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☒ T _c	☐ T _t through subarea	

SHEET FLOW (applicable to T_c only)

	Segment ID	1	1	
1. Surface description (table 3-1)		Short Grass	Paved	
2. Manning's roughness coefficient, n (table 3-1)		0.15	0.011	
3. Flow length, L (total L, 300 ft)		75	225	
4. Two-year 24-hour rainfall, P ₂		2.45	2.45	
5. Land slope, s		0.017	0.011	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t		0.1582	0.0561	= 0.2143

SHALLOW CONCENTRATED FLOW

	Segment ID	2		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L		675		
9. Watercourse slope, s		0.02		
10. Average velocity, V (figure 3-1)		2.2818		
11. $T_t = \frac{L}{3600 V}$ Compute T _t		0.0822		= 0.0822

CHANNEL FLOW

	Segment ID	3		
12. Cross sectional flow area, a		7.0686		
13. Wetted perimeter, p _w		9.4248		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r		0.7500		
15. Channel slope, s		0.006		
16. Manning's roughness coefficient, n		0.013		
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V		7.3287		
18. Flow length, L		680		
11. $T_t = \frac{L}{3600 V}$ Compute T _t		0.0258		= 0.0258
20. Watershed or subarea T _c or T _t (add T _t in steps 6, 11 and 19)				= 0.3222

4 of 4 = 19.3 Minutes



APPENDIX C

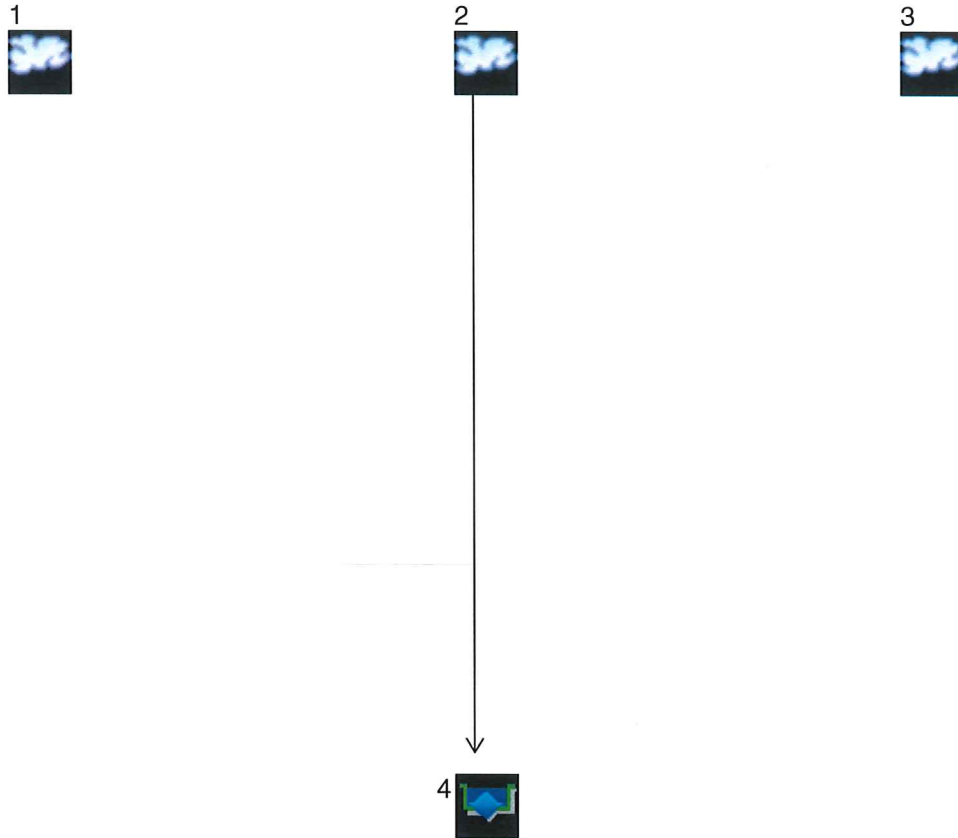
DETENTION CALCULATIONS USING HYDRAFLOW

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Pond Report - DETENTION PIPE	8
IDF Report	9

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066



Legend

Hyd.	Origin	Description
1	SCS Runoff	Existing 10-yr
2	SCS Runoff	Proposed Detained 10-yr
3	SCS Runoff	Proposed Undetained 10-yr
4	Reservoir	Detained Routed (10)

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

[illegible]

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	1.154	1	498	22,435	-----	-----	-----	Existing 10-yr
2	SCS Runoff	1.621	1	481	24,251	-----	-----	-----	Proposed Detained 10-yr
3	SCS Runoff	0.220	1	483	3,599	-----	-----	-----	Proposed Undetained 10-yr
4	Reservoir	0.933	1	502	24,250	2	85.50	1,885	Detained Routed (10)
BVRS 10yr Detention.gpw					Return Period: 10 Year			Wednesday, Dec 22, 2021	

Hydrograph Report

4

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

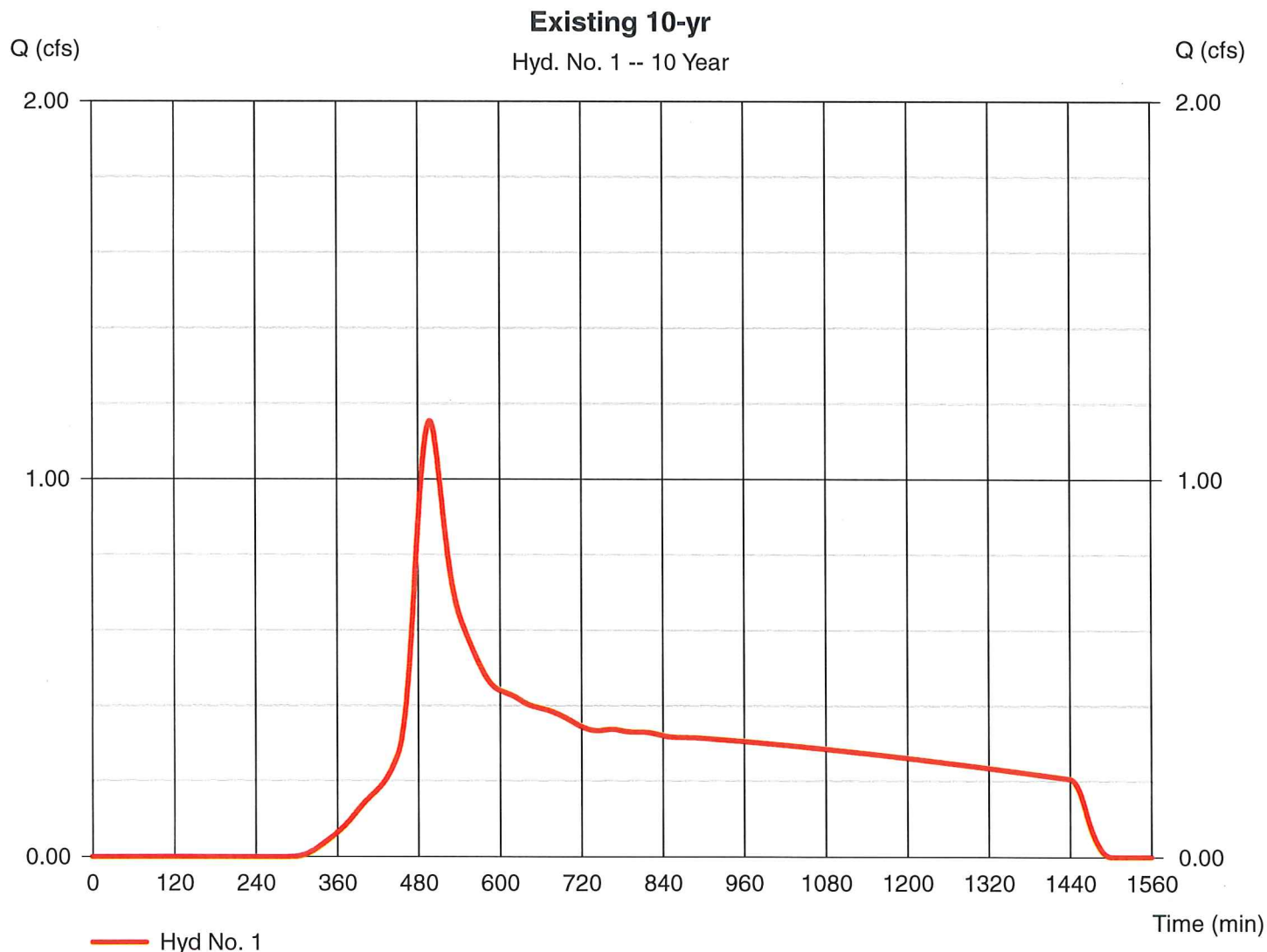
Wednesday, Dec 22, 2021

Hyd. No. 1

Existing 10-yr

Hydrograph type = SCS Runoff
Storm frequency = 10 yrs
Time interval = 1 min
Drainage area = 3.260 ac
Basin Slope = 0.0 %
Tc method = USER
Total precip. = 4.12 in
Storm duration = 24 hrs

Peak discharge = 1.154 cfs
Time to peak = 498 min
Hyd. volume = 22,435 cuft
Curve number = 77
Hydraulic length = 0 ft
Time of conc. (Tc) = 37.80 min
Distribution = Type IA
Shape factor = 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

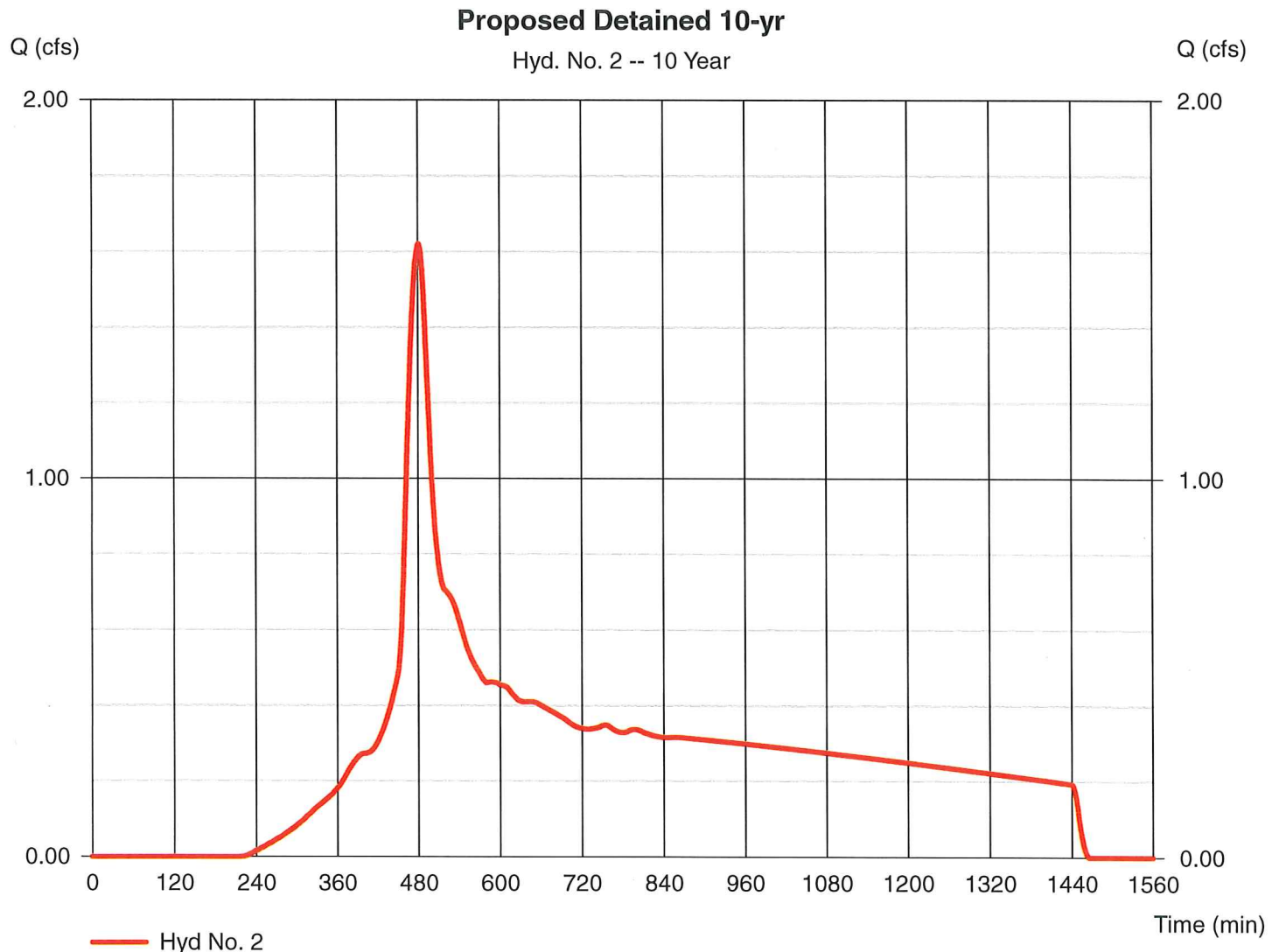
Wednesday, Dec 22, 2021

Hyd. No. 2

Proposed Detained 10-yr

Hydrograph type = SCS Runoff
 Storm frequency = 10 yrs
 Time interval = 1 min
 Drainage area = 2.760 ac
 Basin Slope = 0.0 %
 Tc method = USER
 Total precip. = 4.12 in
 Storm duration = 24 hrs

Peak discharge = 1.621 cfs
 Time to peak = 481 min
 Hyd. volume = 24,251 cuft
 Curve number = 83
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 15.90 min
 Distribution = Type IA
 Shape factor = 484



Hydrograph Report

6

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

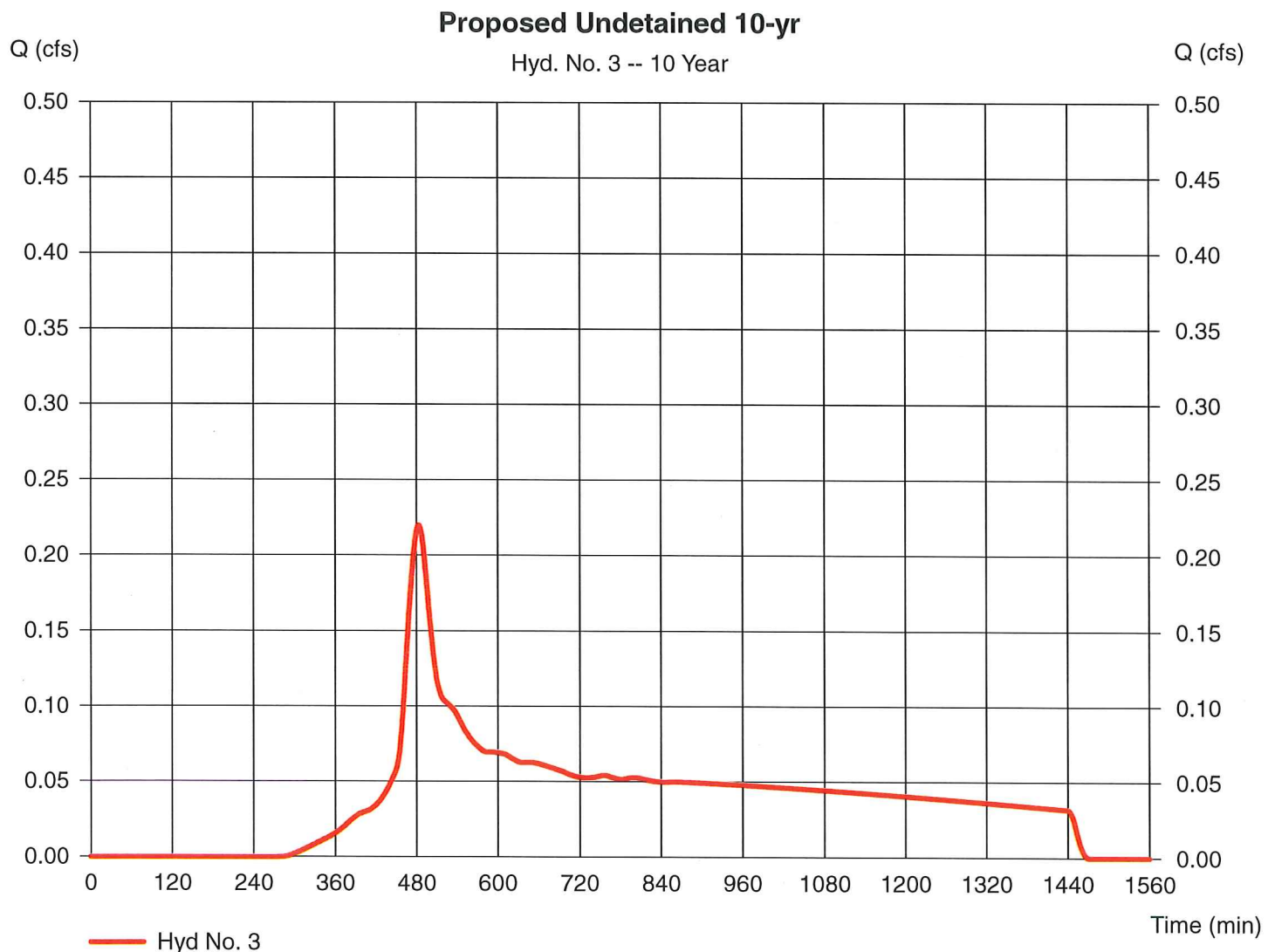
Wednesday, Dec 22, 2021

Hyd. No. 3

Proposed Undetained 10-yr

Hydrograph type = SCS Runoff
Storm frequency = 10 yrs
Time interval = 1 min
Drainage area = 0.500 ac
Basin Slope = 0.0 %
Tc method = USER
Total precip. = 4.12 in
Storm duration = 24 hrs

Peak discharge = 0.220 cfs
Time to peak = 483 min
Hyd. volume = 3,599 cuft
Curve number = 78
Hydraulic length = 0 ft
Time of conc. (Tc) = 19.30 min
Distribution = Type IA
Shape factor = 484



Hydrograph Report

7

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Wednesday, Dec 22, 2021

Hyd. No. 4

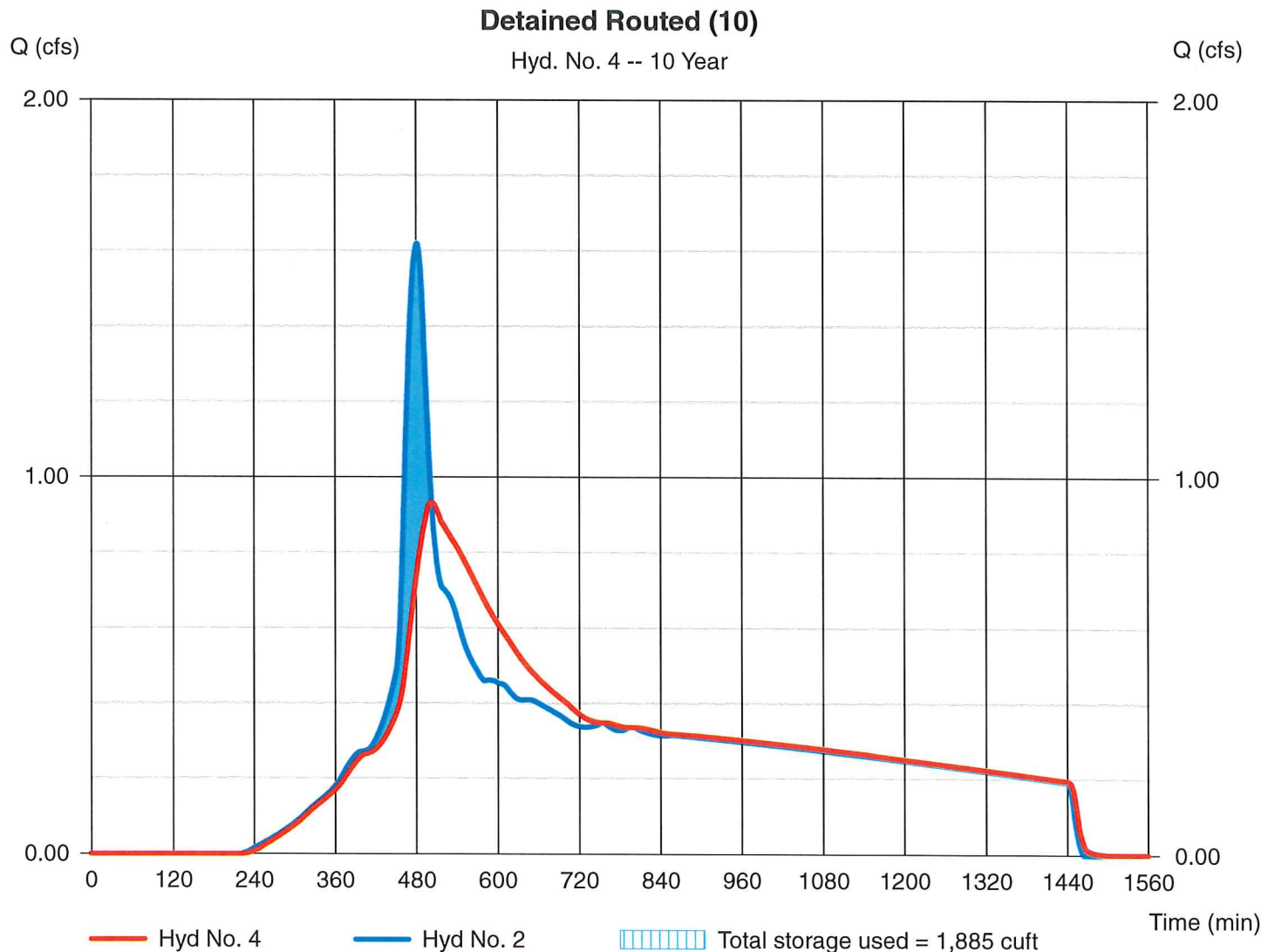
Detained Routed (10)

Hydrograph type = Reservoir
Storm frequency = 10 yrs
Time interval = 1 min
Inflow hyd. No. = 2 - Proposed Detained 10-yr
Reservoir name = DETENTION PIPE

Peak discharge = 0.933 cfs
Time to peak = 502 min
Hyd. volume = 24,250 cuft
Max. Elevation = 85.50 ft
Max. Storage = 1,885 cuft

Storage Indication method used.

REQUIRED



Pond Report

8

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Wednesday, Dec 22, 2021

Pond No. 1 - DETENTION PIPE

Pond Data

UG Chambers - Invert elev. = 81.50 ft, Rise x Span = 4.00 x 4.00 ft, Barrel Len = 150.00 ft, No. Barrels = 1, Slope = 0.00%, Headers = No

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	81.50	n/a	0	0
0.40	81.90	n/a	98	98
0.80	82.30	n/a	170	268
1.20	82.70	n/a	208	476
1.60	83.10	n/a	229	704
2.00	83.50	n/a	239	943
2.40	83.90	n/a	239	1,182
2.80	84.30	n/a	229	1,410
3.20	84.70	n/a	207	1,618
3.60	85.10	n/a	170	1,788
4.00	85.50	n/a	97	1,885

Culvert / Orifice Structures

10-12 ORIFICE

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 2.00	0.00	0.00	0.00
Span (in)	= 7.05	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 81.50	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	81.50	0.00	---	---	---	---	---	---	---	---	---	0.000
0.40	98	81.90	0.27 ic	---	---	---	---	---	---	---	---	---	0.265
0.80	268	82.30	0.40 ic	---	---	---	---	---	---	---	---	---	0.399
1.20	476	82.70	0.50 ic	---	---	---	---	---	---	---	---	---	0.499
1.60	704	83.10	0.58 ic	---	---	---	---	---	---	---	---	---	0.581
2.00	943	83.50	0.65 ic	---	---	---	---	---	---	---	---	---	0.653
2.40	1,182	83.90	0.72 ic	---	---	---	---	---	---	---	---	---	0.718
2.80	1,410	84.30	0.78 ic	---	---	---	---	---	---	---	---	---	0.778
3.20	1,618	84.70	0.83 ic	---	---	---	---	---	---	---	---	---	0.833
3.60	1,788	85.10	0.88 ic	---	---	---	---	---	---	---	---	---	0.885
4.00	1,885	85.50	0.93 ic	---	---	---	---	---	---	---	---	---	0.934

PROVIDED

File name: NAPA.IDF

Tc = time in minutes. Values may exceed 60.

[illegible]

CONCLUSION

These calculations identify and describe the impacts of the proposed Browns Valley Road Subdivision on the hydrologic characteristics of the site and quantify the necessary storage requirement for the detention facility. The storm drain system of Browns Valley Road Subdivision is designed such that the proposed post-developed flow discharge from the development will not exceed pre-developed levels in accordance with the City of Napa Drainage Standards.

Summary of hydrologic analysis:

10-year Pre & Post Developed Flow Discharge

Pre-developed peak run-off =	1.154 cfs
Post-developed (Undetained) peak run-off =	0.220 cfs
Post-developed (Detained) peak run-off =	0.933 cfs
Post-developed flow discharge =	1.153 cfs

Results

10-year: 1.153 cfs (Post-developed) ≤ 1.154 cfs (Pre-developed) ✓

Detention Volume Requirement

Detention volume required =	1,885 ft ³ or 0.0433 ac-ft
Detention volume provided * =	1,885 ft ³ or 0.0433 ac-ft

Results

Detention: 1,885 ft³ (required) = 1,885 ft³ (provided) ✓

Orifice Requirement

The routing and detention are accomplished by a broad crested orifice in the metering structure after the detention pipes.

The required orifice dimensions are: 2 inches high & 7.05 inches long.

SEE BELOW FOR DETENTION PLAN

