Prepared for

Market-Pine Green Alley (Pilot Project)
Preliminary Design Report

Redding, CA

Prepared by

Geosyntec consultants

engineers | scientists | innovators

924 Anacapa Street, Suite 4A
Santa Barbara, CA 93101

Geosyntec Project #: LA0443

February 2019

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1 INTRODUCTION

1.1 Background

As part of the Redding Stormwater Resource Plan (Geosyntec 2018), the City of Redding (City) identified an opportunity to implement a green alley pilot study within the existing Market-Pine Alley (Alley) to capture, treat, and infiltrate stormwater flows (Project). The Project area is shown below in Figure 1. The goal of the Project is to demonstrate the potential water quality, flood control, and groundwater recharge benefits of implementing small scale green alley projects throughout the City.

The Alley is bounded by Eureka Way and Shasta Street and primarily receives sheet flow runoff from approximately 1.9 acres of adjacent buildings and parking lots. An existing storm drain and grate inlet near Eureka Way collects runoff from a small upstream area (less than 1 acre) and conveys this runoff downstream through the Alley, eventually flowing into the Sacramento River which has a TMDL for cadmium, copper, and zinc. The Project overlies the Anderson groundwater basin, which is designated for municipal supply use, and may provide recharge benefit via infiltration to this basin.

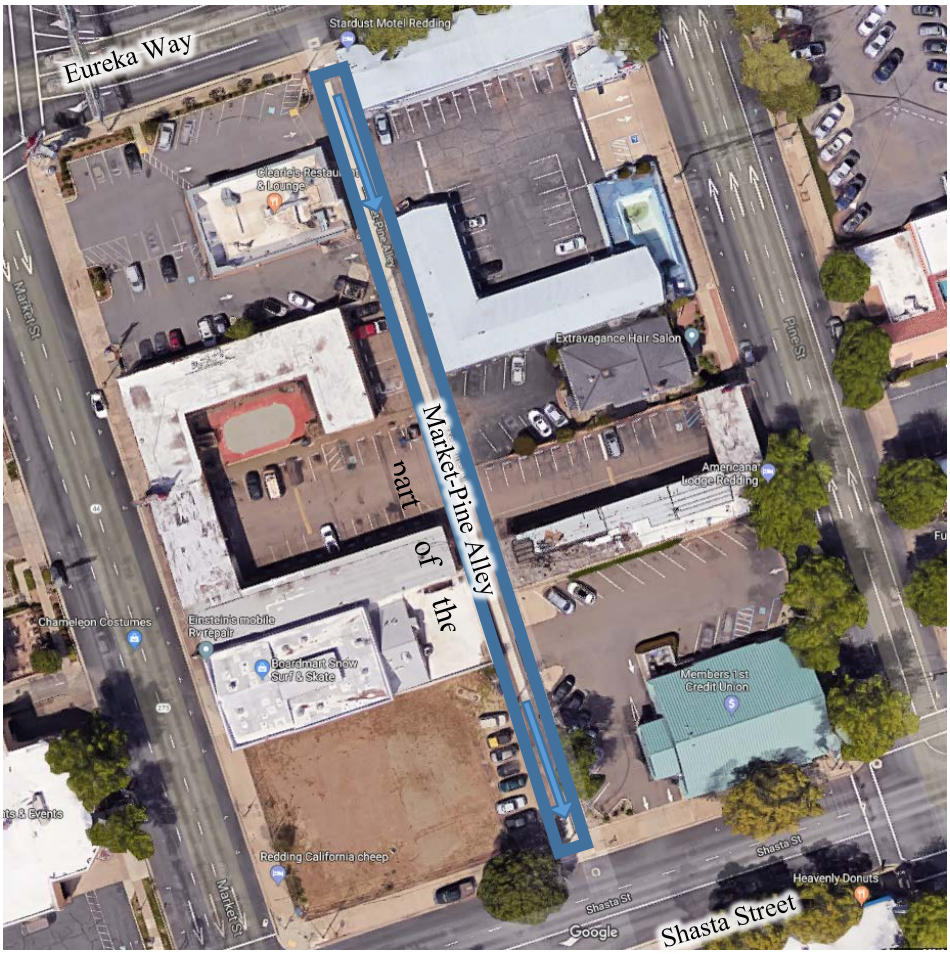


Figure 1: Market-Pine Alley Existing Project Footprint

The proposed Project consists of installing permeable pavers, a gravel storage layer, and an underdrain along the Alley. The permeable pavers are designed to remove sediment and associated particulate pollutants such as metals from the stormwater. The gravel layer provides additional storage space to increase groundwater recharge potential. The underdrain will promote positive drainage of captured runoff towards the existing storm drain system downstream.

The purpose of this report is to present the methodology and results of the preliminary design and sizing analyses performed to achieve the Project goals and recommend future actions to complete the Project design. While not included for this Alley, the accompanying design drawings also include other typical green alley Best Management Practices (BMPs) that can be implemented in similar alleys throughout the City.

1.2 Preliminary Investigation

Geosyntec reviewed City-provided as-builts and utility shapefiles and additional utility information from the City's Electric Department and Anderson Cottonwood Irrigation District.

A site visit was conducted on Wednesday, May 23, 2018, to assess the project feasibility and refine the proposed concept originally outlined in the City's Stormwater Resource Plan (Geosyntec 2018). One constant head infiltration test was conducted in the Alley and demonstrated infiltration may be feasible, although additional evaluations should be completed to confirm the infiltration rate to be used in storage layer and underdrain design.

The results of this preliminary investigation are included in the Market-Pine Green Alley Pilot Project Field Feasibility Assessment Summary Memo (Appendix A) and were used to develop initial design sizing and layout as described in the following sections.

2 PRELIMINARY DESIGN OVERVIEW

This section presents a summary of the key design inputs and calculated values required to effectively size and implement the Project to meet the design goal of capturing and treating the runoff volume (5,300 ft^3) of the 85^{th} percentile 24-hour storm event.

The Alley will be replaced with permeable pavers underlined with a bedding and filter course (1.5 to 3 inches thick), an aggregate layer (1.8 feet), and a bottom filter course. The aggregate depth, assuming the width is fixed by the available area within the alley, was sized so that the total aggregate pore space volume (assuming a porosity of 0.35) will be able to capture and store the 85^{th} percentile 24-hour design volume. The drawdown time was calculated to be 15 hours by using the field infiltration rate and a factor of safety of two. This value is significantly less than the required 72 hours, which reduces the risk of vector concerns. The paver system will also include an underdrain to promote positive drainage of larger storm volumes downstream. During these larger storms, a portion of the stormwater will infiltrate and additional stormwater will be conveyed via the underdrain to the downstream storm drain system once the storage capacity in the aggregate layer is reached

Preliminary design parameter values are shown in Table 1, and calculations are provided in Appendix B. Appendix C includes a preliminary site plan and detail sheet, while Appendix D contains a preliminary project work plan, cost estimate, and schedule. Additional design details and analysis will be required during later stages of design as outlined in Section 3 below.

Table 1. Preliminary Design Parameters

Description	Parameter	Value
Project Drainage Area	85th percentile 24-hour storm depth (in)	0.91[1]
	Area (acre)	1.9
	Imperviousness (%)	86
	Runoff coefficient	0.83
	Design Runoff volume (ft^3)	5,300
Soil Infiltration	Field infiltration rate (in/h)	1
	Infiltration factor of safety	2
Permeable Paver Design Attributes	Aggregate type	open-graded No. 57
	Aggregate porosity	0.35
	Infiltrating area (ft^2)	8,400
	Depth of trench fill (ft)	1.8
	Drawdown time (h)	15
	Bedding and filter course depth (in)	3

3 RECOMMENDED NEXT STEPS

This Report documents the preliminary design layout and sizing performed for the Project. Before implementation of the Project can be confirmed to be feasible and taken to final design, additional analyses and steps should be performed, including:

- A site topographical survey to obtain detailed elevation and constraint information;
- Additional infiltration testing to confirm the representative infiltration rate;
- Utility investigation and potholing to determine if shallow utilities will impact the proposed design;
- Additional calculations and/or hydraulic modeling to satisfy City drainage plan check requirements; and
- Development of construction drawings including additional design details such as final elevations, sizes, and material types and quantities.

[1] City of Redding. *Post-Construction Standards Plan.*

4 REFERENCES

City of Redding, 2016. *Post-Construction Standards Plan.* May 2016.

Geosyntec Consultants, 2018. *City of Redding Stormwater Resource Plan.* October 2018.

APPENDIX A

MARKET-PINE GREEN ALLEY PILOT PROJECT

FIELD FEASIBILITY ASSESSMENT SUMMARY MEMO

Geosyntec consultants

924 Anacapa Street, Suite 4A
Santa Barbara, California 93101
PH 805.897.3800
FAX 805.899.8689
www.geosyntec.com

Memorandum

Date:	14 February 2019
To:	Mieke Sheffield; City of Redding
From:	Avery Blackwell, PE, Brandon Steets, PE, Adam Questad, PE, and Maia Colyar, Geosyntec Consultants
Subject:	Market-Pine Green Alley Pilot Project Field Feasibility Assessment Summary Geosyntec Project: LA0443
Attachments:	Attachment A – Figure 1. Field Investigation Map, Field Logs and Calculations

INTRODUCTION AND BACKGROUND

The City of Redding (City) has identified a conceptual pilot project to create a green alley within the existing Market-Pine Alley in the City's downtown area (Project). As part of the conceptual project, permeable pavement and other green alley Best Management Practices (BMPs) such as rain gardens will be used to reduce stormwater runoff volume through infiltration and also provide water quality benefit. During the Redding Stormwater Resource Plan[1] a desktop evaluation of the project location identified an approximately 3.5-acre drainage area consisting of commercial and transportation land uses overlaying the Anderson groundwater basin, potentially enabling percolation to the aquifer. Potential constraints identified during the desktop feasibility analysis included limited percolation, presence of underground utilities, and the required coordination between adjacent business owners.

This memorandum summarizes the field assessments performed to evaluate Project feasibility, constraints, necessary design modifications, and recommendations for next steps.

[1] Geosyntec Consultants, 2018. City of Redding Stormwater Resource Plan. October 2018.

SITE ASSESSMENT

On May 23, 2018, Geosyntec staff visited the Project location to gather information to assess project feasibility and refine the proposed concept design based on identified constrains. A site investigation map is included in Attachment A. The following key observations were made:

1) A significant portion of the drainage area identified during desktop screening does not drain to the Market-Pine alley. The high points of adjacent parking lots and buildings were recorded and used to revise the Project's drainage area.
2) A catch basin was observed north of the Project on Eureka Way, which collects runoff from an upstream drainage area. The catch basin rim invert is lower than the alley's elevation and therefore diverting runoff from the upstream drainage area was determined to be infeasible without pumping. The revised Project's drainage area is approximately 1.9 acres.
3) The slope of the green alley from the side towards the center ranges from 2.5 – 6.5% depending on the section evaluated and the longitudinal slope ranges from 0.5 – 1.3%.
4) The total width of the alley varies between 19 and 22 feet.
5) The ponding depth provided by the existing alley's depression is approximately 0.75 – 2.0 inches (i.e., the change in elevation between the center low point and the adjacent edges).

As a result of this site assessment, the Market-Pine Green Alley Project was determined to be feasible; however, the drainage area contributing to the project may be minimal (1.9 acres), thus resulting in a lower quantity of stormwater captured and infiltrated. Due to the narrow width of the alley and the required clearance widths (City requirement of 22 feet) for emergency vehicles, only permeable pavers were considered feasible in this location.

SOIL INVESTIGATION

To assess the Project's underlying soil types and infiltration potential, a soil investigation was performed on May 23, 2018. A soil investigation site was located within the Project's footprint and selected to characterize the type and infiltration potential of the various soil types that may be present. One boring (BH-MP-1) was dug using a hand auger and the soil types were logged in accordance with the Unified Soil Classification System (USCS). The boring was dug to approximately 5.4 feet below the ground surface, at which point a concrete surface was encountered limiting the depth of the boring (no other locations were available within the project footprint to hand auger another bore hole). No water was encountered in the boring.

After the boring was complete, the bore hole was backfilled with cleaned gravel and used for infiltration testing. A constant head infiltration test was conducted in general accordance with the Well Permeameter Method, USBR 7300-89, from the US Bureau of Reclamation to estimate the saturated hydraulic conductivity or infiltration potential. Water was applied to the gravel until a

constant head could be maintained. The volume and time elapsed were recorded and used to calculate the hydraulic conductivity summarized in the table below. The soil log, infiltration test results, and hydraulic conductivity calculations can be found in Attachment A.

Table 1. Soil Infiltration Testing Summary

Boring ID	Latitude	Longitude	Ground Surface Elevation (feet AMSL[b])	Depth to Bottom of Boring (inches bgs[c])	Depth to Water (inches bgs)	Saturated Hydraulic Conductivity (inches/hour)
BH-MP-1	40.586862	-122.391274	565	65	not encountered	1.00

a. above mean sea level
b. below ground surface

As shown on the boring logs presented in Attachment A, the subsurface soils generally consisted of sandy soil at the surface and sandy silty material below. Per the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soil classification, the rate shown in the above table is within the range of typical saturated conductivity values for the materials present (~0.56-1.52 inches per hour)[2]. The Los Angeles County *Low Impact Development Standards Manual*[3] recommend an infiltration rate greater than 0.3 in/hr for infiltration features to be feasible at a given site.

As a result of this soil investigation, it was determined that surface infiltration is likely feasible due to the calculated saturated hydraulic conductivity being above the recommended minimum value and lack of shallow groundwater observed at the depths studied. Additional infiltration and geotechnical evaluations should be performed to further assess the infiltration potential of the project and identify design modifications.

UTILITY REQUEST

A utility investigation was performed to identify potential utility constraints within the Project's footprint. The City provided utility shapefiles and as-builts by e-mail between June 7 – 8, 2018. Utility owner contact information was acquired from the USA North 811 underground service alert of Northern/Central California and Nevada[4], and each identified owner with contact information was emailed and/or called between June 6-15, 2018 to request information about the type and

[2] USDA NRCS. *Saturated Hydraulic Conductivity | NRCS Soils.* Retrieved on January 2, 2019 from https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/office/ssr10/tr/?cid=nrcs144p2_074846
[3] Los Angeles County, 2014. *Guidelines for Design, Investigation, and Reporting for LID Stormwater Infiltration.*
[4] https://www.usanorth811.org/

location of utilities near the Project. Written utility information was received from the City of Redding Electric Department and verbal information was received from the Anderson Cottonwood Irrigation District. The remaining utilities did not respond to the information requests. A summary of the information requested and received is provided in the table below.

Table 2: Utility Investigation Summary (potential constraints bolded)

Utility	Owner	Response received?	Data Provided	Description/ Location	Potential constraints?
Electricity	**City of Redding Electric Department**	**Yes**	**Written description**	**Electric lines cross alley**	**Yes**
Electricity, Stormwater, Sanitary Sewer, Water	**City of Redding Public Works**	**Yes**	**As-builts, Shapefiles**	**Electricity, sanitary sewer, and storm drain along alley**	**Yes, shallow utilities could impact design**
Telecommunications	Falcon CTV Redding	No	-	-	-
Telecommunications	Pacific Bell	No	-	-	-
Electricity, Gas	PG&E District Redding	No	-	-	-
Water	Anderson Cottonwood Irrigation	Yes	Verbal description	No utilities in project footprint	No

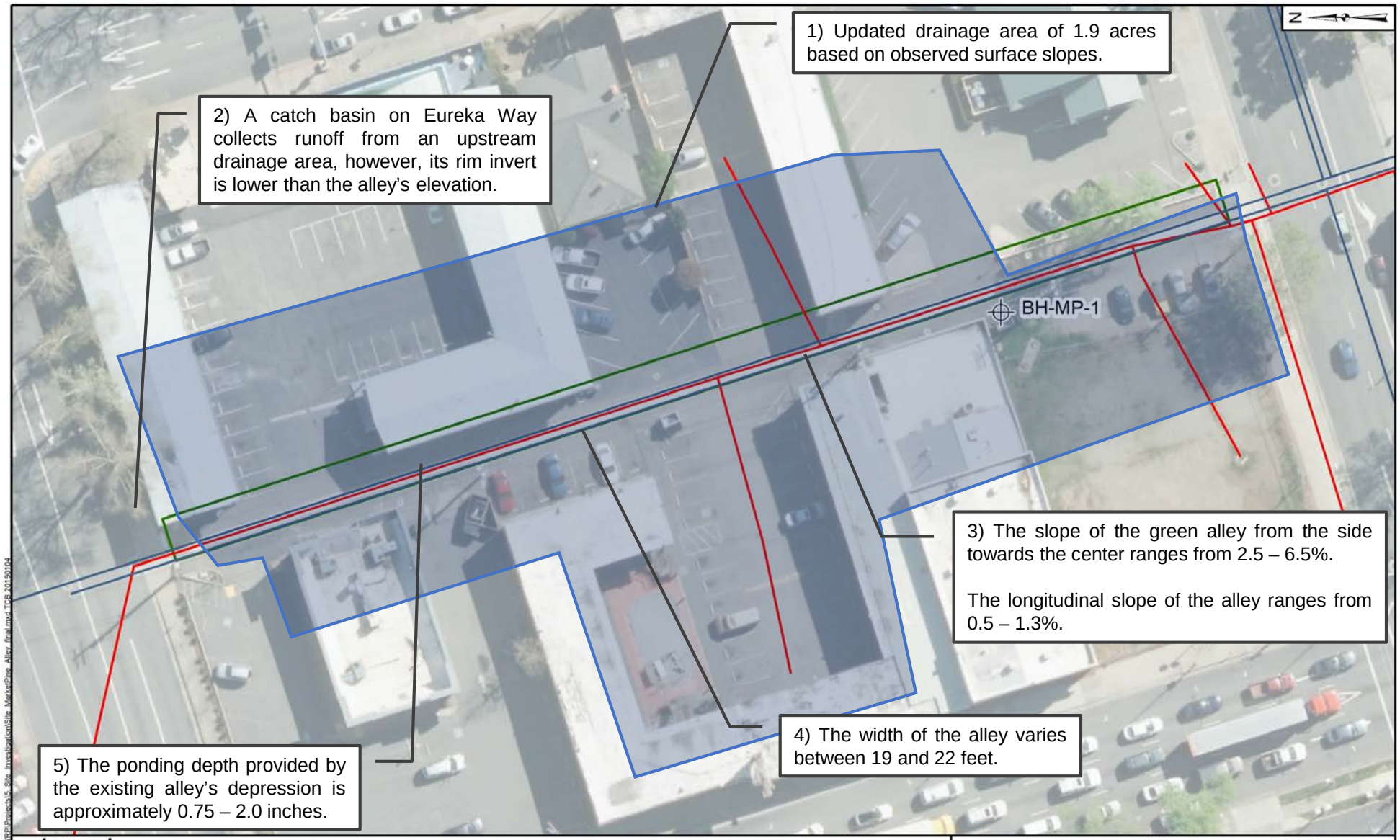
As a result of this utility investigation, potential utility constraints identified include the City's underground electric lines and sanitary sewer, which run through the Market-Pine Green Alley Pilot Project's footprint. Invert elevations of utilities will need to be determined and the feasibility of aligning underdrains to avoid existing utilities must be evaluated during subsequent design phases.

CONCLUSION

Based on the investigations performed, the Project was determined to be feasible, but the provided benefits may be lower than originally estimated in the desktop screening. In addition, it is recommended to only provide permeable pavement and avoid the installation of other BMPs in order to maintain the required clearance within the alley for emergency vehicles. The soil investigation results suggest that an infiltration BMP is feasible at this location; however, due to its use as a vehicle and pedestrian corridor, an underdrain should be installed to prevent excessive ponding and meet vector control drawdown requirements. Finally, the permeable pavement depths

and final underdrain alignments will need to be placed to avoid existing utilities or utility relocation will be required as part of this project. Additional potholing may be required to better assess the exact locations of potential utility constraints.

* * * * *



Legend

- Soil Bore Hole
- Flow Diversion
- Waterbody
- BMP Footprint
- Wastewater Pipe
- Storm Drain

0 50 100 Feet

Market-Pine Alley Field Investigation Map

City of Redding Stormwater Resource Plan

Geosyntec consultants

Santa Barbara | January 2019

Figure 1

Geosyntec consultants
2100 Main St
Suite 150
Huntington Beach, CA 92648
Tel: (714) 969-0800
Fax: (714) 969-0820

GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING BH-MP-1 SHEET — OF —
START DRILL DATE 5/23/18 ELEVATION DATA:
FINISH DRILL DATE GROUND SURF.
LOCATION Market Pine Alley TOP OF CASING
PROJECT NUMBER LA0443 Redevelopment DATUM

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 2) Soil/Rock Name 3) Color 4) Moisture 5) Grain Size 6) Percentage 7) Plasticity 8) Density/Consistency 9) Structure 10) Other (Mineralization, Discoloration, Odor, etc.)	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE: SAMPLE NO.	SAMPLE: TYPE	SAMPLE:	SAMPLE: RECOVERY (%)	SAMPLE: PID READING (ppm)	SAMPLE: TIME (00:00)	COMMENTS 1) Rig Behavior 2) Air Monitoring
3 6 9 12"	brown, gravelysoil loose topsoil 8" gravely sandy silty dark red/brown, moist 11" sandy gravely clayey dark red/brown, moist 19" silty/clay dark red/brown, moist											
2'												
3'												
4'												
5'	65" hit cement? @ N. Side of hole			EOB 5' 5"								
6'												
7'												

CONTRACTOR
EQUIPMENT
DRILL MTHD
DIAMETER
LOGGER
REVIEWER
NORTHING
EASTING
COORDINATE SYSTEM:

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

07-WELL BORE BLANKS 0104.GPJ GEOSNTEC.GDT 3/16/07

Well Infiltration Test-Time and Volume Measurements

Project	LA0443	**Ground elev. (ft)**		Notes: hit rock/cement? at N corner of bottom of well w/ bit leading
Boring ID	BH-MP-1	**GWT depth bgs (ft)**	N/A	
Date	5/23/18	**Depth to botttom of well (ft)**	5'5"	
Tested by	MC AO	**Radius of well (ft)**	3.25"	
Ground temp (°C)		**Depth to water surface in well (ft)**	2"	
Flow rate (gpm)		**Height of water in well (ft)**		

Time		Totalizer Reading (gal)	Difference (gal)	Accum Flow (gal)	Water Temperature (°C)	
Clock	Accum (min)				Well	Tank
		10178.06				
14:55	0	10216.50				
	5	10221.27	4.77			
	10	10225.90	4.63			
	15	10230.48	4.58			
	20	10235.09	4.61			
	25	10239.70	4.61			
	30	10244.27	4.57			
	35	10248.81	4.44		84°F	
	40	10253.30	4.49			
15:40	45	10257.57	4.27		86°F	
	50.5	10262.25				
	55	10266.08			84°F	
	60	10270.30	4.22			
	65	10274.36	4.06		84°F	
	70	10278.48	4.12			
	80	10286.40	7.92			
	85	10290.37	3.97			
	90	10294.38	4.01		85°F	
	95	10298.41	4.03			
	100	10302.55	4.14			
	105	10306.56	4.01			
	110	10310.63	4.07		84°F	
	115	10314.66	4.03		85°F	
	~~120~~ 118	10316.94	2.28			
	120	10318.52	3.86			
	123	10320.84	3.90			

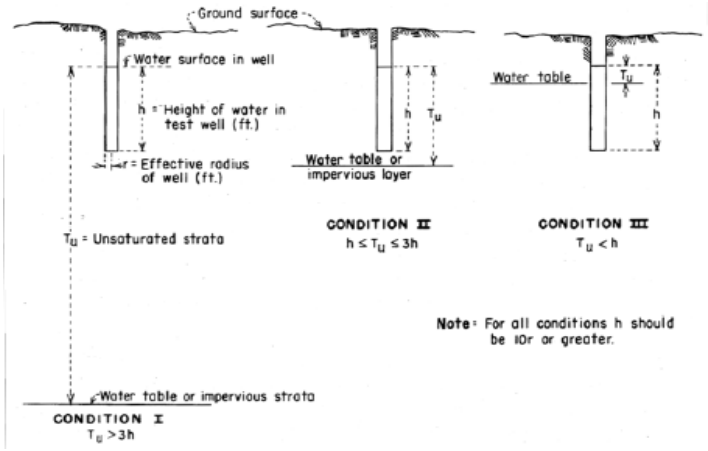
Borehole	Depth bgs	Soil Name	Color	Moisture	Grain Size	Percentage (Gravel, Sand, Silt)
BH-MP-1	0-8"	Well graded sand (SW)	Very Dark Grayish Brown (10YR 3/2)	Dry	Fine to Coarse sands and gravels	35, 65, 0
	8-11"	Well graded sand (SW)	Dusky Red (10R 3/2)	Moist	Fine to Coarse sands and gravels	30, 70, 0
	11-19"	Well graded gravels (GW)	Dusky Red (10R 3/2)	Moist	Fine to coarse sands and gravels	60, 40, 0
	19-65"	Silty sand (SM)	Dusky Red (10R 3/2)	Slightly moist	Fine to coarse sands w/ silt	0, 70, 30

Well Infiltration Test- Time and Volume Measurements

Project	LA0443	Ground Elev. (ft)	565	Notes:
Boring ID	BH-MP-1	GWT Depth bgs (ft)	-	
Date	5/23/2018	Depth to Botttom of Well (ft)	5.42	
Tested By	MC, AQ	Radius of Well (ft)	0.27	
Ground Temp (^{o}C)	29	Depth to water surface in well (ft)	0.17	
Flow Rate (gpm)	0.807	Height of water in well (ft)	5.25	

Time		Totalizer Reading (gal)	Difference (gal)	Accum Flow (gal)	Water Temperature	
Clock	Accum (min)				Well	Tank
	-	10,178.06	0.00	0.00		
	0	10,216.50	38.44	38.44		
	5	10,221.27	4.77	43.21		
	10	10,225.90	4.63	47.84		
	15	10,230.48	4.58	52.42		
	20	10,235.09	4.61	57.03		
	25	10,239.70	4.61	61.64		
	30	10,244.37	4.67	66.31		
	35	10,248.81	4.44	70.75		
	40	10,253.00	4.19	74.94		
	45	10,257.57	4.57	79.51		
	50.5	10,262.25	4.68	84.19		
	55	10,266.08	3.83	88.02		
	60	10,270.30	4.22	92.24		
	65	10,274.36	4.06	96.30		
	70	10,278.48	4.12	100.42		
	80	10,286.40	7.92	108.34		
	85	10,290.37	3.97	112.31		
	90	10,294.38	4.01	116.32		
	95	10,298.41	4.03	120.35		
	100	10,302.55	4.14	124.49		
	105	10306.56	4.01	128.50		
	110	10310.63	4.07	132.57		
	115	10314.66	4.03	136.60		
	118	10316.94	2.28	138.88		
	120	10318.52	1.58	140.46		
	123	10320.84	2.32	142.78		

Boring ID	Flow Rate, q q gpm	Flow Rate, q q ft^3/hr	Temperature Correction V	Head h ft	Well Radius r ft	Water Surface to GWT Depth T_u ft	Saturated Hydraulic Conductivity k_{20} ft/hr	Saturated Hydraulic Conductivity k_{20} cm/s	Saturated Hydraulic Conductivity k_{20} in/hr	Condition
BH-MP-1	0.8075	6.48	0.83	5.3	0.271	-	8.4E-02	7.1E-04	1.00	1



Condition 1:

$$K_s = \frac{Q(\mu_T/\mu_{20})}{2\pi H^2}\left[\ln\left[\frac{H}{r}+\sqrt{\left(\frac{H}{r}\right)^2+1}\right]-\frac{\sqrt{1+\left(\frac{H}{r}\right)^2}}{\frac{H}{r}}+\frac{r}{H}\right]$$

Condition 2:

$$K_s = \frac{Q(\mu_{20}/\mu_T)}{2\pi H^2}\left[\frac{\ln\left(\frac{H}{r}\right)}{\frac{1}{6}+\frac{1}{3}\left(\frac{H}{T_u}\right)^{-1}}\right]$$

Condition 3:

Condition III:

$$k_{20} = \frac{qV}{2\pi h^2}\left[\frac{\ln\left(\frac{h}{r}\right)}{\left(\frac{h}{T_u}\right)^{-1}+\frac{1}{2}\left(\frac{h}{T_u}\right)^{-2}}\right]$$

K_s = saturated hydraulic conductivity (infiltration rate, inches/hour)
H = height of water in well (inches)
Q = percolation flow rate from selected time interval (cubic inches/hour)
r = effective radius of well (inches)
μ_T = viscosity of water at water temperature, T
μ_{20} = viscosity of water at 20° C
T_u = unsaturated distance between the water surface and the water table or impervious strata

Temp (C)	Dynamic Viscosity
0	1.787
5	1.519
10	1.307
11	1.2843
12	1.247
13	1.2111
14	1.1766
15	1.1435
16	1.1118
17	1.0815
18	1.0526
19	1.0251
20	1.002
21	0.9743
22	0.951
23	0.9291
24	0.9086
25	0.8895
26	0.8718
27	0.8555
28	0.8406
29	0.8271
30	0.815
31	0.8043
32	0.795

Temperature - t - (^oC)	Dynamic Viscosity - μ - (Pa s, N s/m^2) x 10^{-3}	Kinematic Viscosity - ν - (m^2/s) x 10^{-6}
0	1.787	1.787
5	1.519	1.519
10	1.307	1.307
20	1.002	1.004
30	0.798	0.801
40	0.653	0.658
50	0.547	0.553
60	0.467	0.475
70	0.404	0.413
80	0.355	0.365
90	0.315	0.326
100	0.282	0.294

u = 0.0007*t^2 - 0.0534*t + 1.7785 R^2 = 0.9993

APPENDIX B

PRELIMINARY DESIGN CALCULATIONS

GREEN ALLEY STORAGE DESIGN

The runoff coefficient, *C*, was calculated as

$$C = 0.95 \cdot imp + C_p(1 - imp) = 0.95(0.86) + 0.12(1 - 0.86) = 0.83$$

where *imp* is the fraction of the drainage area that is impervious.

The runoff volume, *V*, was calculated as

$$V = CdA = (0.83)(0.91\ in)(83{,}143\ ft^2) = 5{,}257\ ft^3 = 39{,}325\ gal$$

where *d* is the 85th percentile 24-hour storm depth and *A* is the drainage area.

The designed **depth of trench fill**, d_t, was calculated as

$$d_t = \frac{V}{A_p \varepsilon} = \frac{5257\ ft^3}{(8392\ ft^2)(0.35)} = \mathbf{1.8\ ft}$$

where A_p is the permeable pavers surface area, which is based on site constraints, and ε is the aggregate porosity. This depth does not account for the volume of existing utilities or for the volume of the proposed underdrain.

The **drawdown time**, *t*, was calculated as

$$t = \frac{d_t f \varepsilon}{i} = \frac{(1.8\ ft)(2)(0.35)}{1\ in/h} = \mathbf{15\ h}$$

where *f* is the factor of safety and *i* is the field infiltration

APPENDIX C

PRELIMINARY DESIGN SHEETS

LOCATION MAP:
SCALE 1" = 60'

CITY OF REDDING

MARKET–PINE GREEN ALLEY PRELIMINARY DESIGN

PROJECT LOCATION:
MARKET–PINE ALLEY FROM EUREKA WAY TO SHASTA ST
REDDING, CA 96001

FEBRUARY 2019

PROJECT TEAM:

APPLICANT:
CITY OF REDDING
777 CYPRESS AVE
REDDING, CA 96001
(530) 224–6068

CIVIL ENGINEER:
GEOSYNTEC CONSULTANTS, INC.
924 ANACAPA ST, SUITE 4A
SANTA BARBARA, CA 93101
(310) 957–6100

PROJECT DESCRIPTION:

INSTALL PERMEABLE PAVERS, STORAGE GRAVEL LAYER, AND AN UNDERDRAIN ALONG THE ALLEY.

DRAWING INDEX		
SHEET NO.	DRAWING NO.	DRAWING TITLE
1	G–01	TITLE SHEET AND DRAWING INDEX
2	C–01	SITE PLAN
3	C–02	EXAMPLE DETAILS

REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
DATE

Geosyntec consultants
engineers | scientists | innovators

MARKET–PINE ALLEY FROM EUREKA WAY TO SHASTA ST, REDDING, CA

CITY OF REDDING SWRP:
MARKET–PINE GREEN ALLEY
PRELIMINARY DESIGN
TITLE SHEET AND DRAWING INDEX

JOB NO. LA0443
DRAWING NO. G–01
SCALE AS SHOWN
SHEET NO. 01 OF 03

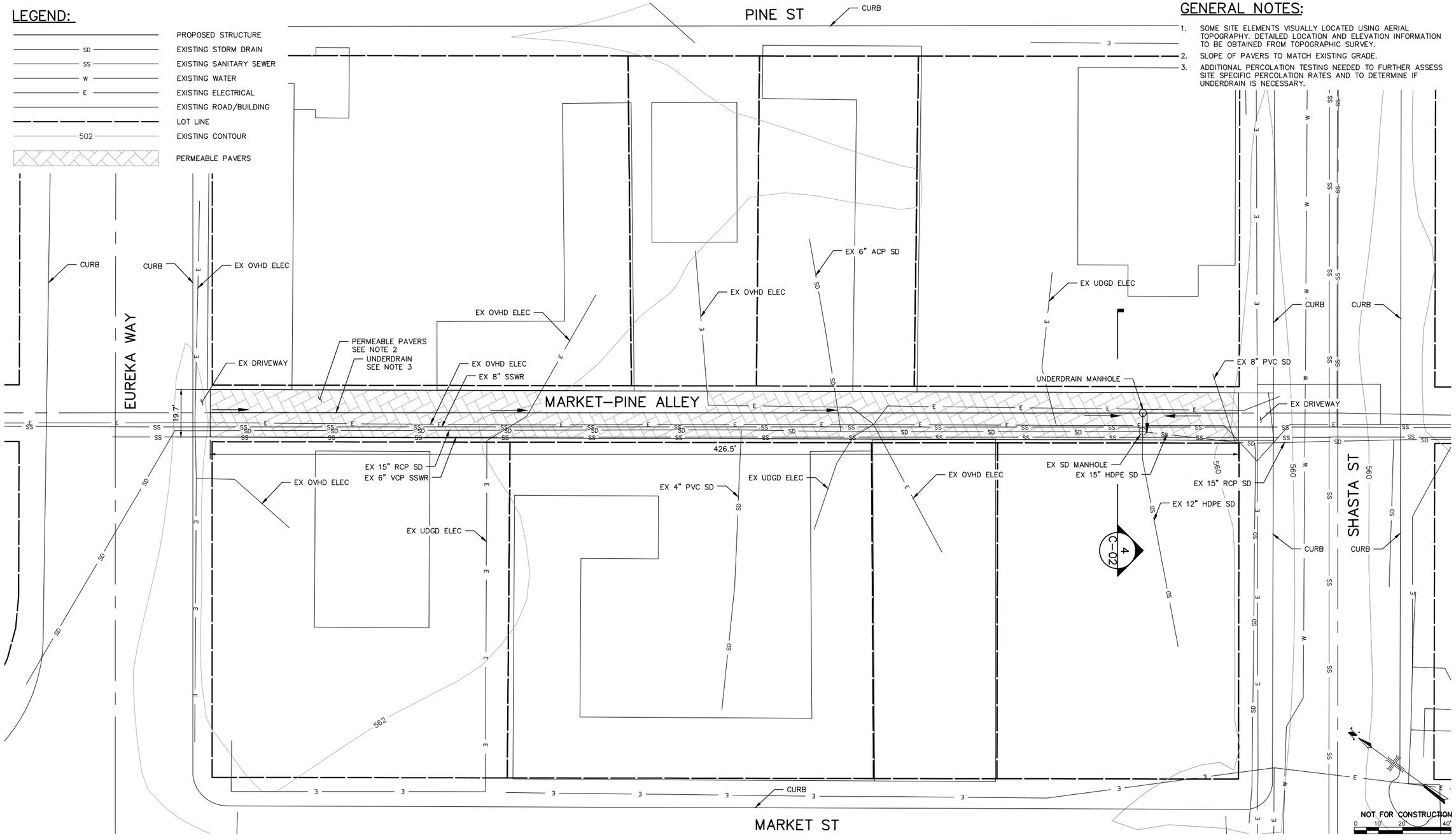
Z:\Project Folders\LA0443 – City of Redding SWRP\CAD\Market-Pine CAD\Drawings\MKPN-G-01 new.dwg
February 13, 2019 – 2:38pm AGroyStewart

LEGEND:

- PROPOSED STRUCTURE
- SD — EXISTING STORM DRAIN
- SS — EXISTING SANITARY SEWER
- W — EXISTING WATER
- E — EXISTING ELECTRICAL
- EXISTING ROAD/BUILDING
- LOT LINE
- 502 — EXISTING CONTOUR
- PERMEABLE PAVERS

GENERAL NOTES:

1. SOME SITE ELEMENTS VISUALLY LOCATED USING AERIAL TOPOGRAPHY. DETAILED LOCATION AND ELEVATION INFORMATION TO BE OBTAINED FROM TOPOGRAPHIC SURVEY.
2. SLOPE OF PAVERS TO MATCH EXISTING GRADE.
3. ADDITIONAL PERCOLATION TESTING NEEDED TO FURTHER ASSESS SITE SPECIFIC PERCOLATION RATES AND TO DETERMINE IF UNDERDRAIN IS NECESSARY.



REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
DATE

Geosyntec consultants
engineers | scientists | innovators

CITY OF REDDING CALIFORNIA

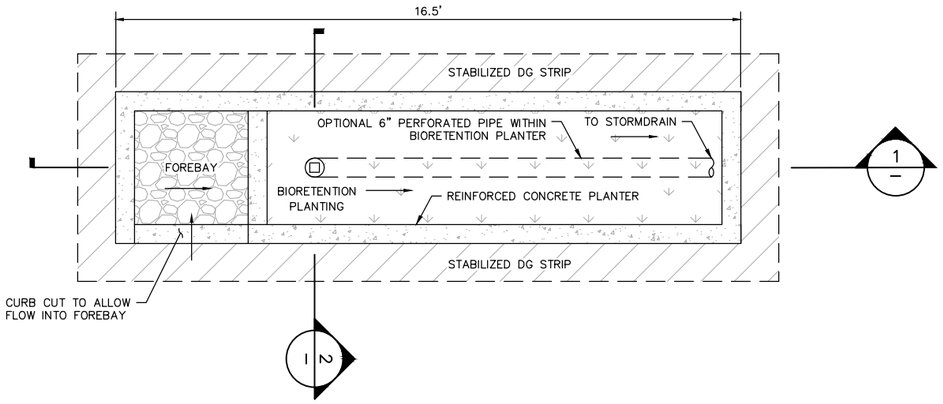
MARKET–PINE ALLEY FROM EUREKA WAY TO SHASTA ST, REDDING, CA

CITY OF REDDING SWRP: MARKET–PINE GREEN ALLEY PRELIMINARY DESIGN

SITE PLAN

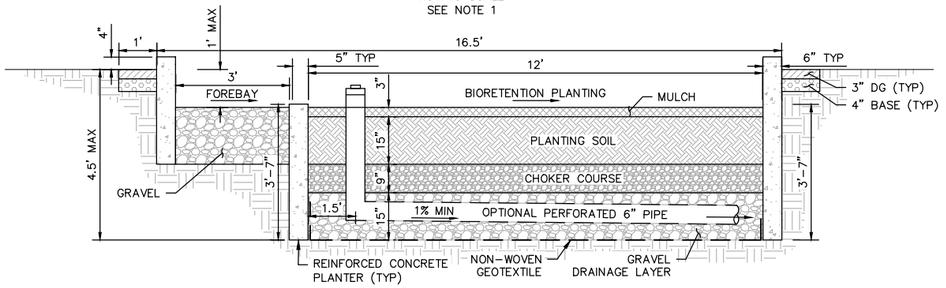
JOB NO. LA0443
DRAWING NO. C-01
SCALE 1"=20'
SHEET NO. 02 OF 03

Z:\Project Folders\LA0443 - City of Redding SWRP\CAD\Market-Pine CAD\Drawings\MKPN-C-01.dwg
February 13, 2019 - 5:00pm AGraySteward



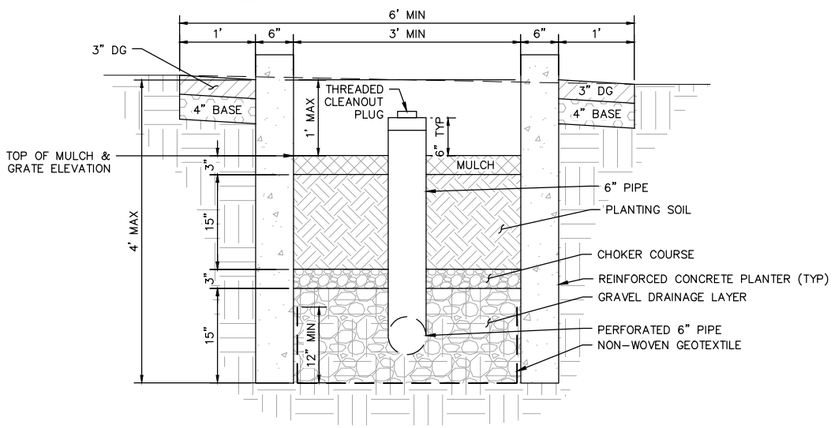
TYPICAL RAIN GARDEN PLAN

NOT TO SCALE
SEE NOTE 1



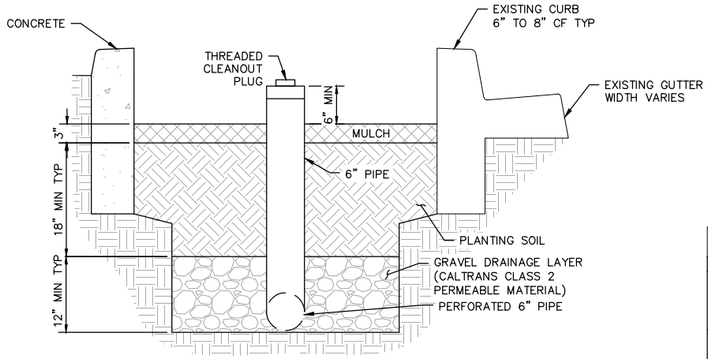
1 — TYPICAL RAIN GARDEN SECTION

NOT TO SCALE
SEE NOTE 1



2 — TYPICAL RAIN GARDEN SECTION

NOT TO SCALE
SEE NOTE 1

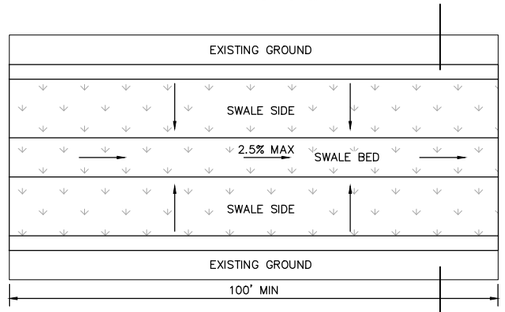


TYPICAL PLANTER BOX SECTION

NOT TO SCALE
SEE NOTE 1

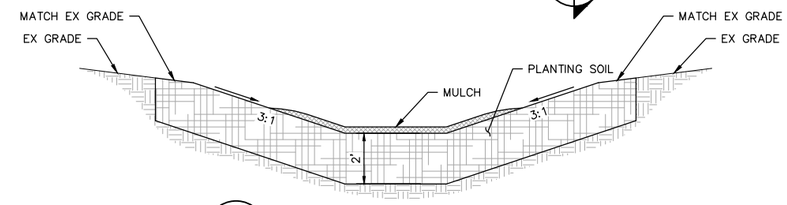
NOTES:

1. TYPICAL DETAILS (E.G. RAIN GARDEN, PLANTER BOX, TREE PLANTER BOX, AND SWALE) ARE SHOWN FOR POTENTIAL USE IN OTHER GREEN ALLEY PROJECTS WITHIN THE CITY. DUE TO SPACE CONSTRAINTS IN THE MARKET-PINE ALLEY, ONLY PERMEABLE PAVERS WILL BE USED FOR THIS PILOT PROJECT. ALL NUMBERS ARE FOR ILLUSTRATIVE PURPOSES ONLY.
2. LANDSCAPE ARCHITECTS SHALL SPECIFY PLANTING REQUIREMENTS INCLUDING SOIL TYPE AND ROOT BALL DEPTH ALLOWANCES.
3. AN IMPERMEABLE LINER IS REQUIRED ON THE VERTICAL SIDES OF THE SECTION TO PREVENT MIGRATION OF WATER UNDER THE ADJACENT BUILDINGS.



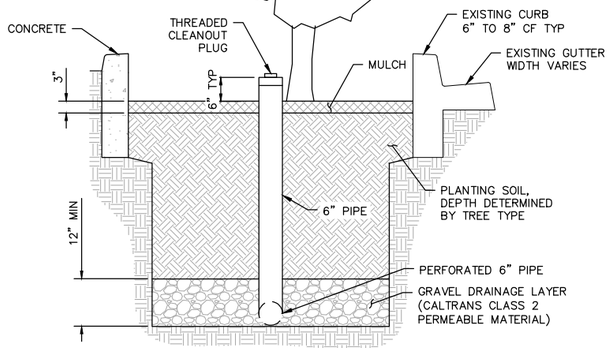
TYPICAL SWALE PLAN

NOT TO SCALE
SEE NOTE 1



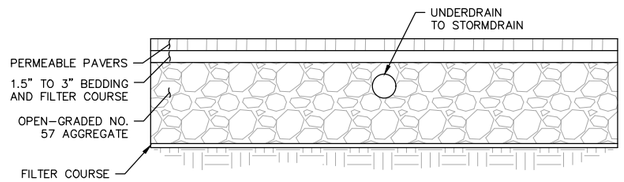
3 — TYPICAL SWALE SECTION

NOT TO SCALE
SEE NOTE 1



TYPICAL TREE PLANTER BOX SECTION

NOT TO SCALE
SEE NOTES 1 AND 2



4 C-01 — PERMEABLE PAVERS SECTION

NOT TO SCALE
SEE NOTE 3

REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
DATE

Geosyntec consultants
engineers | scientists | innovators

CITY OF REDDING CALIFORNIA

REDDING, CA

CITY OF REDDING SWRP: MARKET-PINE ALLEY PRELIMINARY DESIGN

EXAMPLE DETAILS

JOB NO.	LA0443
DRAWING NO.	C-02
SCALE	NOT TO SCALE
SHEET NO.	03 OF 03

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February 13, 2019 - 5:04pm AGrayStewart

APPENDIX D

PRELIMINARY DESIGN WORK PLAN, COST ESTIMATE, AND SCHEDULE

Geosyntec consultants

924 Anacapa Street, Suite 4A
Santa Barbara, California 93101
PH 805.897.3800
FAX 805.899.8689
www.geosyntec.com

Memorandum

Date:	14 February 2019
To:	Mieke Sheffield; City of Redding
From:	Avery Blackwell, PE, Brandon Steets, PE, and Adam Questad, PE, Geosyntec Consultants
Subject:	Market-Pine Green Alley (Pilot Project) Work Plan, Cost Estimate, and Schedule Geosyntec Project: LA0443
Attachments:	Attachment A – Preliminary Cost Estimate Attachment B – Preliminary Schedule

INTRODUCTION AND BACKGROUND

The City of Redding (City) identified an opportunity to implement a green alley pilot study within the existing Market-Pine Alley (Alley) to capture, treat, and infiltrate stormwater flows (Project). The Alley is bounded by Eureka Way and Shasta Street and primarily receives sheet flow runoff from approximately 1.9 acres of adjacent buildings and parking lots. An existing storm drain and grate inlet near Eureka Way collects runoff from a small upstream area (less than 1 acre) and conveys this runoff downstream through the Alley. The proposed Project consists of installing permeable pavers, a gravel storage layer, and an underdrain along the Alley. The permeable pavers are designed to remove sediment and associated particulate pollutants such as metals from the stormwater. The gravel layer provides additional storage space to increase groundwater recharge potential. The underdrain will promote positive drainage of captured runoff towards the existing storm drain system downstream.

This memorandum describes the preliminary project work plan, cost estimate, and schedule developed for the Project, in a format consistent with the Proposition 1 Stormwater Grant Program (SWGP) Implementation Grant Proposal Templates[1].

[1] https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swgp/prop1/

PRELIMINARY PROJECT WORK PLAN

Task 1. Project Administration

The Project will be managed by the City, who will oversee all aspects of the Project, including but not limited to planning, permitting, design, construction, bid and award, monitoring, coordination with other entities, and project maintenance, to ensure that all tasks are completed on time and within budget. The following tasks are included under Project Administration and will be executed by the City:

- **Project Management:** To keep the Project on schedule and within budgetary limitations, this subtask includes overall project management to coordinate consultants and subcontractors, track schedule and progression of the Project, track expenditures and budget status, and time for internal City communication and meetings to discuss the Project with other departments.

- **Invoicing:** As required by the final agreement, this subtask includes time to develop invoices and the required backup and supporting information from all subconsultants and consultants.

- **Reporting:** This subtask includes time to develop quarterly and annual reports and other more frequent communication with the grant manager (if the Project receives grant funding).

Task 2. Planning/Design/Engineering/Environmental

The City will oversee the selection of an engineering consultant to develop 100% Construction design drawings and specifications based on the current preliminary designs and feedback from community stakeholders and regulatory agencies. A preliminary site investigation and design for the Project have been completed and are described in subsequent sections of the work plan. To develop the final design for the Project, the following subtasks will be completed by the City, engineering consultant, or subcontractor[2]:

- **Survey and Geotechnical Investigation:** To revise the current base plan shown in the preliminary design, a topographical survey will be executed to understand detailed

[2] The City may consider an alternative to the design-bid-build approach and instead establish a design-build contract with one consultant team. The design-build approach is typically lower cost due to the construction contractor being involved during final design and the removal of the construction bidding process. In addition, design-build contracts promote a partnership where all parties work together and are committed to the same goals, which can result in a more successful project and higher likelihood of achieving the Project's goals within the budget allotment.

elevation information of existing conditions and potential aboveground constraints. This subtask will also include utility investigation and potholing to identify shallow utilities that may impact the proposed design. Finally, additional geotechnical investigations including boreholes and possibly test pits will be executed to characterize subsurface conditions and further clarify the infiltration capacity of the soil.

- **Hydrologic and Hydraulic Analysis:** Additional calculations and modeling will be performed to finalize the final elevations, size, and material of the Project's required infrastructure. Additionally, hydraulic modeling will be performed to satisfy the City's plan check requirements.

- **CEQA and Permitting:** The City, with the assistance of a consultant, will prepare the required CEQA documentation and develop the material required to obtain the applicable permits, which may include encroachment permits, building permits, grading permits, and construction stormwater permits.

- **Final Design:** Based on the preliminary design developed and the information gathered in the previous subtasks, a consultant will then advance the design and prepare a 100% construction plan set and technical specifications outlining the project's components with sufficient detail for the contractor to construct the project. This task will also include a revised cost estimate based on the final design's alignment and components.

- **Bid Documents and Construction Award:** Upon completion of the final design, the City or a consultant will prepare the construction bid package and solicit competitive construction bids from qualified contractors. The City will then award the project to a qualified contractor and provide notice to proceed once all contract documents are in place.

Task 3. Construction/Implementation

The following subtasks are included for the administrative management of construction:

- **Contract Administration:** The City will serve as Project Manager throughout construction and the Engineer of Record or qualified engineering consultant(s) will be contracted by the City to provide engineering support during all phases of construction. The City and consultant(s) will coordinate activities with the contractor, review and approve contractor submittals, and make project decisions as required when conflicts or discrepancies are identified in the field. The City will be responsible for all external reporting requirements as necessary to fulfill the needs of any applicable grants.

- **Construction Management:** The City will contract a qualified construction manager to oversee construction activities and contractor coordination including conducting tailgate meetings, reviewing the contractor's execution of tasks, communication of progress and concerns to the City or consultant through daily and/or weekly reporting, and performing other general construction management responsibilities.

The following subtasks are expected to be executed by the construction subcontractor as part of this Project although the following tasks may be revised after the final design is complete:

- **Contractor mobilization** – After the contractor is provided with the notice to proceed, they will begin mobilization to the site, which may include establishing cost tracking tools and metrics, ordering material and assembling their crews, establishing a staging area if not provided by the City, and equipment rentals.
- **Demolition** – After mobilization, the existing pavement within the Project's footprint, along with the subgrade and subsurface layers extending to the depth required of the Project, will be demolished. The material will then be removed and hauled away for proper disposal.
- **Excavation and existing stormdrain tie-in** – After demolition, a trench will be installed with adequate stabilization to prevent collapse during construction. The existing stormdrain and catch basins will be located and prepared for future tie-in as part of the Project. Excavated material will be stockpiled as needed and hauled offsite for proper disposal.
- **Permeable Paver Installation** – After completion of excavation, the gravel layer and underdrain will be installed according to the final design plans and specifications. The underdrain will tie-in to the existing stormdrain network as shown in the plans. The required bedding, filter course, and permeable pavers will then be installed to match the existing grade within the alley. The trenches will then be backfilled and grading of adjacent soil will be provided as-needed.
- **Punch list completion** – Throughout construction, the engineer of record, City, or construction manager will maintain a punch list of items that need to be corrected by the contractor. After completion of the subtasks above, the contractor will be required to address all punch list items before a certificate of occupancy can be issued by the inspector.
- **Demobilization** – After construction is complete the contractor will remove any equipment or facilities used specifically for this project and clean up the site as needed..

Task 4. Monitoring/Performance

To assess the Project's performance the following monitoring/performance subtasks will be implemented:

- **Monitoring Plan and Quality Assurance Project Plan (QAPP):** A consultant will develop a detailed monitoring plan to outline the required monitoring procedures and methods for collecting post-construction data and evaluating data collected to determine the effectiveness of the Project and whether the multiple benefit goals have been achieved. In addition, this plan will include a QAPP outlining the quality assurance, quality control requirements to prevent sample contamination and produce reliable results.

- **Wet Weather monitoring (Post-construction):** After completion of construction, a consultant will adhere to the monitoring plan and collect wet weather samples from the effluent of the underdrain during the first year (a total of four storms will be targeted). Water quality samples will be analyzed by a lab subcontracted by the City. If any equipment other than sample bottles are required to collect samples, an equipment blank will be collected for 20% of the samples.

Task 5. Education/Outreach

Three public outreach meetings were held in 2018 during the project selection phase and additional education/outreach subtasks will include:

- **Public Communication:** During all stages of the Project, the public will be notified of the Project's progression through e-mail communication and possibly through an established website. In addition, temporary signage will be placed during construction to educate the public on the importance of the Project and the expected goals. After construction, a permanent sign will be installed to describe the project and the multiple benefits it provides including reduced pollutant loading to the Sacramento River and reduction in roadway flooding.

- **Public Meetings:** Two (2) public meetings are planned during the duration of the Project. After kickoff of the final design subtask, a public meeting will be held to discuss the preliminary design concepts and solicit additional feedback from the community. The feedback will be incorporated into the final design as feasible. Prior to construction, an additional public meeting will be held to present the final design and provide information regarding impacts expected during construction.

PRELIMINARY PROJECT COST ESTIMATE

The Project's preliminary cost estimate (Attachment A) has been assembled to match the five major tasks described above. Each task has a number of subtasks which represent various deliverables or stages of the project. The following is a summary of each category and task:

Project Administration: These costs are associated with grant administration and reporting labor and miscellaneous expenses (e.g., communication, photo copies, etc.) necessary to manage and operate a successful grant project.

Planning/Design/Engineering/Environmental: These costs were developed based on similar costs incurred during previous consultant stormwater improvement projects. Subtasks include deliverables necessary to analyze, design and produce engineering documents that are used in the permitting, bidding, construction and completion of the Project.

Construction/Implementation: The construction costs were developed according to the size and material of infrastructure outlined in the preliminary design layout for the Project. The construction cost is estimated to be $390,000 USD. These costs are based on recent 2018 regional stormwater improvement projects, professional experience and judgment, and construction cost indexes (BNi cost books, R. S. Means). Assumptions used to develop the construction costs include:

- Excavated materials from the project area are considered clean and do not require special sampling, waste handling or disposal. The disposal costs assume that the material will be transported to a nearby facility within 15 miles of the project.
- Stormwater Pollution Prevention Plan monitoring requirements are not included since the Project is not expected to disturb more than one acre of land.
- Landscape vegetation will include low maintenance natives that require initial irrigation to establish the plants during the first one to three years.

Monitoring/Performance: These costs are based on developing and implementing a plan to evaluate the performance of the Project. The costs were determined based on previous experience with monitoring programs developed under Proposition 1 and 84 grant projects.

Education/Outreach: The costs associated with these tasks include providing community, direct and web-based outreach and education to support the Project based on education/outreach experience during past projects.

PRELIMINARY PROJECT SCHEDULE

The Project's preliminary schedule (Attachment B) includes tasks consistent with those described in the preliminary project work plan. Task durations were established based on prior experience with design and construction of similar projects and are expected to be sufficient for completion of each task. Timely completion of these tasks will be facilitated by the Project being managed solely by the City, who will coordinate all aspects of the Project. Based on the preliminary analyses performed, the only identified obstacle that may delay project tasks are unanticipated environmental permitting requirements. These requirements will be established during communication with regulators at the outset and therefore the Project's schedule will be revised early on if needed.

The design drawings for the Project have been developed to approximately the 30% level, with the concept fully described including locations of all key infrastructure, and project effectiveness evaluated through both hydrologic calculations and a geotechnical investigation to estimate site-specific infiltration rates, expected infiltration volumes, and resulting pollutant load reductions. The first phase in the Project includes additional surveying, geotechnical investigations, and hydrologic and hydraulic analysis to confirm the proposed layout is feasible or if modifications are required to avoid environmental, grading, or utility constraints in order to meet the stormwater diversion goals of the Project. This phase is expected to last approximately four (4) months.

The next phase will include the development of the design to the 100% level, as well as submittal of applications for appropriate local permits (grading, etc.), and is expected to last approximately three (3) months. Development of a monitoring plan will be completed concurrently with the final designs.

During the last month of design and permitting, the construction contractor selection process will be initiated, and is expected to be completed within four (4) months. As soon as the construction contractor has been selected, construction of the project will commence. Construction is expected to be complete within five (5) months. Once construction is complete, performance monitoring will be conducted, in accordance with the monitoring plan that was developed at the start of the Project.

* * * * *

ATTACHMENT A

MARKET-PINE GREEN ALLEY

PRELIMINARY COST ESTIMATE

Prop 1 STORMWATER GRANT PROGRAM - BUDGET DETAIL

Applicant: City of Redding **FAAST PIN:**

Project: Market-Pine Green Alley (Pilot Project)

Budget Category	Percent of Cost	Labor Costs			Consulting/Materials/Equipment				TOTALS
		Rate	# of Hours	Total Labor	Unit Cost	Units	# of Units	Total Cost	
1. Project Administration	**5.7%**								**$30,000**
Project Management		$100.00	150	$15,000				$0	$15,000
Invoicing		$100.00	50	$5,000				$0	$5,000
Reporting		$100.00	100	$10,000				$0	$10,000
2. Planning/Design/Engineering/ Environmental	**11.3%**								**$60,000**
Design Survey				$0	$7,500.00	LS	1	$7,500	$7,500
Geotechnical Investigation				$0	$7,500.00	LS	1	$7,500	$7,500
Hydrology & Hydraulics				$0	$5,000.00	LS	1	$5,000	$5,000
Construction Documents				$0	$25,000.00	LS	1	$25,000	$25,000
Environmental Approvals/Construction Permits				$0	$15,000.00	LS	1	$15,000	$15,000
3. Construction/Implementation	**72.8%**								**$386,025**
General Conditions/General Requirements				$0	$35,000	LS	1	$35,000	$35,000
Pavement demo & disposal				$0	$25,000	LS	1	$25,000	$25,000
Excavation and trenching				$0	$20,000	LS	1	$20,000	$20,000
Finish Grading				$0	$10,000	LS	1	$10,000	$10,000
Permeable pavers				$0	$15	SF	8400	$126,000	$126,000
Bedding and filter course (1.5 to 3"; assumed 2.5")				$0	$75	CY	65	$4,875	$4,875
Open-graded No. 57 Aggregate (assume 3.5')				$0	$75	CY	1010	$75,750	$75,750
Filter course (assume 2")				$0	$75	CY	52	$3,900	$3,900
Install subdrain				$0	$60	LF	425	$25,500	$25,500
Traffic control				$0	$50,000	LS	1	$50,000	$50,000
Potholing				$0	$10,000	LS	1	$10,000	$10,000
4. Monitoring/Performance	**7.5%**								**$40,000**
Monitoring Plan and Quality Assurance Project Plan				$0	$15,000	LS	1	$15,000	$15,000
Dry and Wet Weather Monitoring (Post-Construction)				$0	$25,000	LS	1	$25,000	$25,000
5. Education/Outreach	**2.6%**								**$14,000**
Public Communication		$100.00	40	$4,000	$1,000	EA	1	$1,000	$5,000
Public Meeting #1		$100.00	20	$2,000	$2,500	EA	1	$2,500	$4,500
Public Meeting #2		$100.00	20	$2,000	$2,500	EA	1	$2,500	$4,500
Grand Total:	**100%**								**$530,025**

ATTACHMENT B

MARKET-PINE GREEN ALLEY PRELIMINARY SCHEDULE

Market-Pine Alley Green Street (Pilot Project)

City of Redding

Legend: Admin | Engineering | Construction | Monitoring | Public Outreach

Work Tasks	Start (month)	Duration (months)
Task 1. Project Administration		
Project Management	1	26
Invoicing	1	26
Reporting	1	26
Task 2. Planning/Design/Engineering/Environmental		
Survey and Geotechnical Investigation	1	2
Hydrologic and Hydraulic Analysis	2	2
CEQA and Permitting	1	6
Final Design	3	4
Bid Documents and Construction Award	7	4
Task 3. Construction/Implementation		
Contract Administration	10	5
Construction Management	11	4
Mobilization	11	1
Demolition	11	0.50
Excavation and existing stormdrain tie-in	12	0.50
Permeable Paver Installation	12	1
Complete punch list	13	1
Demobilization	14	0.25
Task 4. Monitoring/Performance		
Monitoring Plan and Quality Assurance Project Plan	4	6
Post-project monitoring	15	12
Task 5. Public Education and Outreach		
Public communication	1	26.00
Public meeting #1	2	0.25
Public meeting #2	10	0.25