Appendix H:
Hydrology and Water Quality Supporting Information

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PRELIMINARY STORMWATER CONTROL PLAN

for

THE RANCH

Subdivision 9249

City of Antioch, California

September 6, 2019

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This Stormwater Control Plan was prepared using the template dated February 2018.

I. PROJECT DATA

Table 1. Project Data

Project Name/Number	The Ranch
Application Submittal Date	September 2019
Project Location	APNs 057010002, 057010003, and 057021003. West of Deer Valley Road, on both the north and south sides of Sand Creek
Name of Developer	Richland Communities
Project Phase No.	Preliminary plan for entire project for CEQA review
Project Type and Description	Mixed use including residential, Village Center, and future fire station
Project Watershed	Sand Creek draining to Marsh Creek
Total Project Site Area (acres)	551.5 (property boundary as distinct from drainage area)
Total Area of Land Disturbed (acres)	373.6
Total New Impervious Surface Area (sq. ft.)	7,731,723
Total Replaced Impervious Surface Area	10,472
Total Pre-Project Impervious Surface Area	10,472
Total Post-Project Impervious Surface Area	7,731,723
50% Rule [*]	Applies
Project Density	4.6 units/acre (based on impacted area)
Applicable Special Project Categories	Does not apply
Percent LID and non-LID treatment	100% LID for all on-site developed areas
HM Compliance [†]	Applies

[*50% rule applies if:
Total Replaced Impervious Surface Area > 0.5 x Pre-Project Impervious Surface Area]

[†HM required (unless project meets one of the exemptions on *Guidebook* p. 9) if:
(Total New Impervious Surface Area + Total Replaced Impervious Surface Area) ≥ 1 acre]

II. SETTING

II.A. Project Location and Description

The Cowan Property Development Project ("Project") is located within a total property boundary area of roughly 551 acres in the City of Antioch, Contra Costa County. The Project bounds both sides of Sand Creek, a major left bank tributary of Marsh Creek. The project site is located upstream (west) from the Contra Costa County Flood Control District (CCCFCD) Upper Sand Creek Regional Flood Control Basin and west of Deer Valley Road and the Kaiser Permanente Antioch Medical Center. **Figure 1.** illustrates the project site overview.

The Project proposes to construct a mix of land uses directly impacting 322 acres within the site on the north and south sides of Sand Creek. Table 2. provides the overall project site area breakdown for the proposed development areas and open space areas that drain to proposed stormwater management facilities (noting that some of the latter area is outside the property boundaries). A setback of approximately 125 feet from the centerline of the creek has been provided along Sand Creek. Areas within this setback will be protected from development and are considered self-treating areas from the perspective of stormwater management.

Other major infrastructure associated with the project includes a southeaster extension of Dallas Ranch Road across the project site with a proposed bridge over Sand Creek to provide access to the southern development section. Sand Creek Road will connect Deer Valley Road to Dallas Ranch Road and will be aligned to the north of Sand Creek. The project will also include a Village Center and new fire station along the eastern boundary immediately west of Deer Valley Road. A 6+-acre community park will be located within the northern development section and link to sections of the trail network. The project also proposes to maintain roughly 229 acres of open space, trail networks and stormwater facilities for public access.

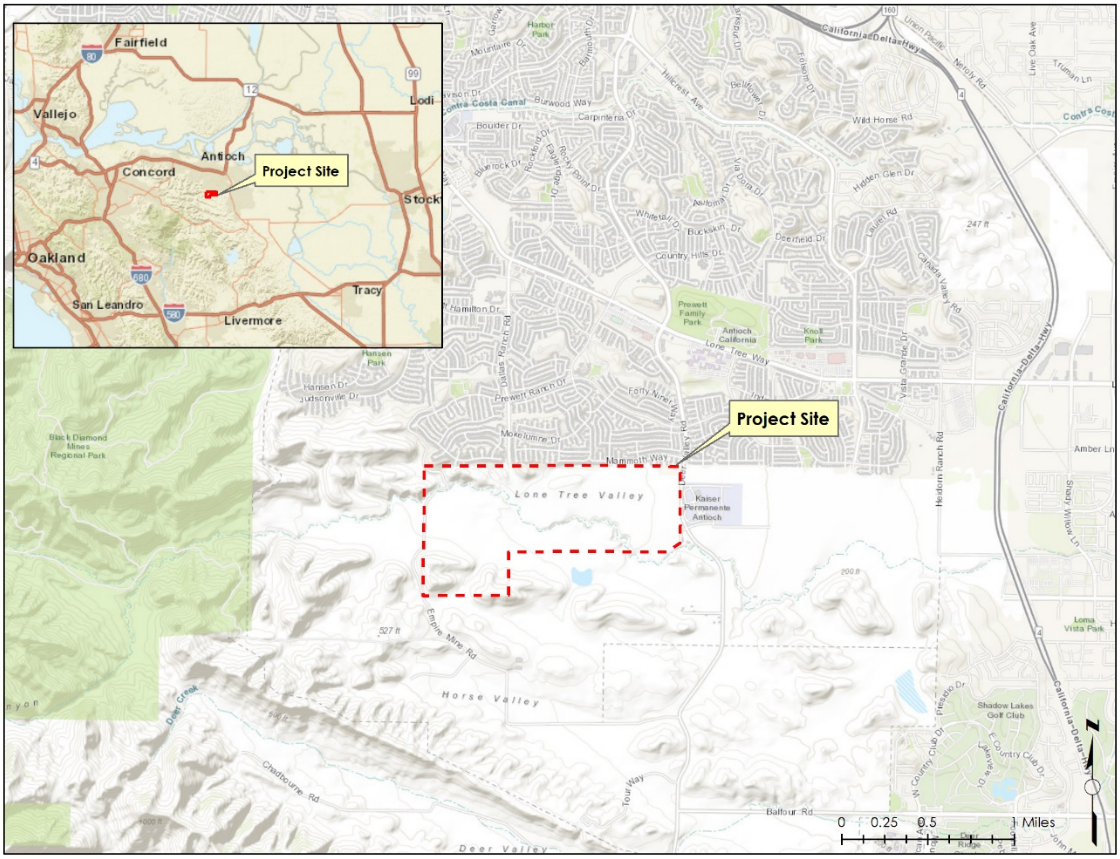

Figure 1. Project Vicinity Map

Table 2. Project Land Use Summary

Project Area Description	Area *(acres)*
Low Density Residential	140.5
Age Restricted Residential	75.0
Med-Low Density Residential	38.0
Community Facilities (village center, fire station, trail staging)	8.0
Parks & Landscape	22.5
Roads	38.0
Trails and Open Space	204.5
Stormwater Facilities	25.0
Total	551.5

II.B. Existing Site Features and Conditions

Currently, the project area is nearly undeveloped open-space/range land, consisting almost exclusively of grassland with mature oak and buckeye trees directly along the riparian corridor of Sand Creek. The site is bordered by Deer Valley Road to the east and Empire Mine Road to the west. To the north of the site is the Dallas Ranch Road Subdivision, with existing housing extending the total length of the northern property boundary. Lands to the south consist of undeveloped open-space / range land. Existing ranch buildings are located within the project boundary to the north of the creek.

The portions of the overall project area that are proposed for development are located on relatively level land that slopes generally parallel to Sand Creek with elevations ranging from 320 feet at the western boundary to 230 feet along the eastern boundary. [1] The slope across the main development areas are relatively constant at roughly 1.4 percent for the northern section and 1.2 percent for the southern section. The southern section backs up to a series of hills that will be preserved as open space. These hills have a peak elevation of 481 feet. Sand Creek flows from west to east through much of the project in a highly-incised channel with a bottom width as narrow as 10 feet and top of bank widths ranging from 150 to 300 feet. The creek bed elevations range from 274 feet to 210 feet over a stream distance of roughly 10,415 feet. This is equivalent to a channel slope of approximately 0.6 percent.

The climate characteristics of the site reflect the Mediterranean climate of central coastal regions of California. This climate regime is characterized by cool, wet winters and hot, dry summers. The lower elevation areas in eastern Contra Costa County lie within the rain shadow of the coastal mountain ranges that remove much of the moisture from incoming storm systems. The Mean Seasonal Isohyets Map prepared by Contra Costa County indicates that the mean annual precipitation at the site is on the order of 14.3 inches per year. Although the average rainfall is quite low, the site does experience the wide range in annual precipitation that accompany drought years and wet years such as those related to the El Niño Southern Oscillation (ENSO). For example, the minimum annual precipitation recorded at the nearby Antioch Pumping Plant was 5.6 inches (in Water Year 1976) and the maximum was 27.1 inches (in Water Year 1983).

Annual temperature patterns are typical of interior areas of the state, although somewhat tempered by cooling breezes originating at sea and in the San Francisco Bay system. Evaporation rates are quite high in summer; exceeding rainfall in all but the wettest winter months. Mean annual pan evaporation is likely on the order of 71 inches, or over five times mean annual precipitation, based on the record from the Antioch Pumping Plant (1955-1978).

Three primary soil types are mapped on the project site per the National Cooperative Soil Survey (**Appendix A**). The soil types present are classified as hydrologic soil groups A and C under the Natural Resources Conservation Service's (NRCS) hydrologic soil group system (HSG).[2] The majority of the project site is underlain by HGS C soils: Capay clay (CaA), Rincon clay loam (RbA),

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[1] Unless otherwise noted, all elevations reference the North American Vertical Datum of 1988 (NAVD 88).

[2] The NRCS hydrologic soil groups (HSGs) divide all soil types into four categories based on the potential to produce runoff. Type A soils have the lowest runoff potential and typically have high infiltration rates. Type D soils have the highest runoff potential and typically have low infiltration rates and/or are shallow.

Altamont clay (AbE), and Altamont- Fontana complex (AcF). There is a small section of HSG A soils located in the southwest corner of the southern section of the site consisting of Briones loamy sand (BdE), but this area comprises only 1.5% of the project property and will not be developed. The areas mapped for the primary stormwater basins are in soil class C; Capay clay for the southern basin and Rincon clay loam for the northern basin.

Pre-project drainage patterns at the site are illustrated in the attached Exhibit 1. The majority of the project area currently drains via sheet flow and shallow swale flow directly to Sand Creek. There are two exceptions found in areas north of the creek. The first of these is a man-made ditch along the north central boundary of the project area that was constructed concurrently with the existing development to the north. This ditch currently conveys runoff from approximately 17.1 acres to the storm drain system located to the north of the project. The second drainage pathway exception is an area along the north portion of the site that drains via sheet flow easterly to Deer Valley Road where it is intercepted by a ditch along the western edge of the roadway and conveyed into 36-inch storm drain line that was constructed as part of the Kaiser medical complex. Runoff from this area (roughly 87.6 acres) is thus conveyed easterly along Wellness Way, to join an existing major trunk storm drain (double 84-inch pipes) that runs south to discharge into the Upper Sand Creek Detention Basin.

Post-project drainage patterns are illustrated in Exhibit 2. Overall drainage patterns will be maintained, with those areas currently draining directly to Sand Creek continuing to do so via the primary project integrated management practices (IMPs) consisting of large stormwater basins on the north and south sides of the creek (IMPs 4 and 5). The development of the northern low-density residential area will remove the existing ditch along the northern side of the property and redirect that runoff into the main northern project storm drain system, ultimately flowing to IMP 4. Three drainage management areas (DMAs 1 to 3) comprising a total of 28.9 acres will continue to drain to the 36-inch line at Deer Valley Road and Wellness Way. Runoff from the future Village Center and fire station sites will ultimately be routed to future IMPs that will be connected to the existing 24-inch storm drain that runs easterly under Sand Creek Road from Deer Valley Road. The latter areas will be developed as separate projects and are considered self-treating areas for the purposes of this Stormwater Control Plan.

An off-site area of approximately 2.8 acres comprising the existing southern end of Dallas Ranch Road currently drains onto the project property and will continue to do so in the post-project drainage configuration.

II.C. Opportunities and Constraints for Stormwater Control

The project presents several important constraints with respect to stormwater management, including the following:

- *Low soil permeability.* The soils underlying the project site are almost exclusively designated as HSG C, indicating very low infiltration potential. This significantly limits those IMPs that rely on direct infiltration of stormwater runoff as a water-quality control measure.
- *Off-site northern watershed.* A 2.8-acre section of land to the north of the site along Dallas Ranch Road is not within the Project boundary but drains to the site. The Project will need to provide stormwater management for this additional off-site watershed area.

- *Existing stormwater drainage ditch*. The drainage ditch along the north side of the Project currently conveys runoff from approximately 17.1 acres of the project property to the off-site storm drain system north. The existing ditch will be removed, and the associated runoff collected and routed as part of DMA 4.
- *No exiting creek outfalls*. The outfall from the primary stormwater basins (IMPs 4 and 5) will each require a new outfall into Sand Creek, with an associated limited amount of hardened surfaces to be added to the creek.
- *Wetland areas*. Some areas of seasonal wetlands have been identified in the area south of Sand Creek. This requires configuring project and associated stormwater management infrastructure to avoid wetland impacts to the maximum extent practicable.

These constraints are offset by a several notable opportunities that include:

- *Preservation of Sand Creek*. The Projects presents an opportunity to preserve and enhance a section of Sand Creek. Preservation of approximately 35 acres along the creek, including the creek corridor and upper banks, is integral to the project design.
- *Parks and open space*. The roughly 229 acres of open space and 20 acres of parks throughout the Project will provide wildlife habitat areas and a wildlife corridor, while significantly limiting the total amount of new impervious cover that will be constructed.
- *Sufficient hydraulic head*. The relief at the site allows stormwater runoff from the developed areas to be routed to, through, and away from treatment controls without pumping.
- *Space for IMPs*. The land plan includes sufficient areas to accommodate IMPs of sufficient size to fully manage stormwater runoff for water-quality treatment and detention/hydromodification control purposes, while still preserving an appropriate set-back distance from the creek top of bank.

III. LOW IMPACT DEVELOPMENT DESIGN STRATEGIES

III.A. Optimization of Site Layout

III.A.1. Limitation of development envelope

As discussed previously, the project land plan will use a compact site design within the developed areas, freeing up substantial areas that will be preserved in the form of parks, trails, creek corridor, and open space. In fact, roughly 35 percent of the total property area will not be developed in any significant way.

III.A.2. Preservation of natural drainage features

No natural drainage features will be impacted by the project. The only significant such feature is Sand Creek itself, for which the entire corridor will be preserved.

III.A.3. Setbacks from creeks, wetlands, and riparian habitats

As per above, the banks of Sand Creek along the project property and the adjoining upland areas will remain undeveloped as part of the recognized 125-foot setback from the creek centerline. A 50-foot setback from the identified wetland areas has been provided where appropriate.

III.A.4. Minimization of imperviousness

Imperviousness is limited primarily through the clustering of development to reduce the overall developed area footprint and preservation of extensive open space areas.

III.A.5. Use of drainage as a design element

All IMPs will be located at the lower elevations of the project site to facilitate gravity flow and will be designed as aesthetic features for the neighboring development, with the facilities designed to integrate into the surrounding open space using curvilinear forms and appropriate landscaping.

III.B. Use of Permeable Pavements

The project does not propose the use of permeable pavers given the very low infiltration capacity of the underlying soils.

III.C. Dispersal of Runoff to Pervious Areas

The limited infiltration capacity of the soils at the site precludes any significant use of runoff dispersal as a stormwater management approach.

III.D. Bioretention or other Integrated Management Practices

To meet the requirements of the pertinent stormwater regulations, the project will construct integrated management practices (IMPs) that provide for full bioretention treatment of all on-site runoff. To meet this objective, the project is divided into five main drainage management areas (DMAs) as shown in Exhibit 2. Within each DMA, a gravity-flow storm drain system will collect stormwater and convey it to an IMP feature specifically sized for the pertinent amount of impervious and pervious cover. In all cases, the IMPs utilize the "cistern + bioretention" sizing criteria taken directly from the Stormwater C.3 Guidebook (7th Edition). The term "cistern" in this case should be recognized as signifying a separate storage volume, in the form of a traditional open basin, which is used to meter flow out to a separate bioretention area in a controlled manner.

The location of the project site in the middle reaches of the Sand Creek watershed also calls for strict compliance with the hydrograph modification plan (HMP) requirements established in Contra Costa County. Full HMP compliance is achieved across the board by sizing the IMPs per calculations using the Clean Water Program's IMP Calculator (see Section IV) for treatment + flow control.

As discussed in Section II, the Project will also provide remedial water-quality treatment for approximately 2.8 acres along Dallas Ranch Road to the north of the site. Runoff from this area will be collected and conveyed as part of DMA 4. All IMPs are designed with full capacity to achieve the traditional C.3 functions for water-quality remediation (through bioretention treatment) and hydromodification management. With the planned addition of debris screens on the IMP outlets, the proposed facilities will provide full compliance with the currently-effective trash TMDL requirements.

Despite the recent completion of the Upper Sand Creek Detention Basin just downstream of the site, the project will configure all IMPs to provide mitigation for any potential increase in peak flow rates from storms larger than the 10-year event (smaller storms are mitigated by the flow control sizing included in the hydromodification control design). This functionality is provided for Contra Costa County Flood Control design storms up to the 100-year event by proper allowances for high-stage storage and appropriate sizing of the high-flow release structures in each facility. The associated modeling and results are discussed in Appendix B.

IV. DOCUMENTATION OF DRAINAGE DESIGN

IV.A. Descriptions of each Drainage Management Area

IV.A.1. Tables of Drainage Management Areas

Table 3. Summary of Northeastern DMA 1 and DMA 2

		Area			Impervious		Pervious
Name	**Surface Type**	*sq-ft*	*acres*	*sq-mi*	*%*	*sq-ft*	*sq-ft*
O1	Total O1	624,611	14.9	0.022	47	295,601	329,010
	Low Density Residential	506,169	13.0	0.018	35	177,159	329,010
	Major Roads	118,442	1.9	0.004	100	118,442	0
O2	Total O2	493,065	11.3	0.018	63	310,094	182,971
	Med Density Residential	389,301	10.3	0.014	53	206,330	182,971
	Major Roads	103,764	1.0	0.004	100	103,764	0
Storm	Stormwater Facilities	104,326	2.4	0.004	100	104,326	0
TOTAL	**DMA 1 & DMA 2**	**1,222,002**	**28.6**	**0.04**	**58**	**710,021**	**511,981**

Table 4. Summary of Northeastern DMA 3

		Area			Impervious		Pervious
Name	**Surface Type**	*sq-ft*	*acres*	*sq-mi*	*%*	*sq-ft*	*sq-ft*
O3	Total O3	25,037	0.6	0.001	83	20,730	4,308
	SW & LS	8,615	0.2	0.000	50	4,308	4,308
	Road	16,422	0.4	0.001	100	16,422	0
Storm	Stormwater Facilities	10,534	0.2	0.000	100	10,534	0
TOTAL	**DMA 3**	**35,571**	**0.8**	**0.001**	**88**	**31,263**	**4,308**

Table 4. Summary of Northern DMA 4

Name	Surface Type	Area			Impervious		Pervious
		sq-ft	*acres*	*sq-mi*	*%*	*sq-ft*	*sq-ft*
N1	Total N1	5,462,424	125.40	0.196	35.9	1,961,289	3,501,135
	Low Density Residential	4,064,148	93.30	0.146	35	1,422,452	2,641,696
	Parks/Landscape	248,292	5.70	0.009	10	24,829	223,463
	Open Space	635,976	14.60	0.023	0	0	635,976
	Major Road	514,008	11.80	0.018	100	514,008	0
N2	Total N2	1,964,556	45.10	0.070	65.1	1,279,836	684,720
	Med Density Residential	1,206,612	27.70	0.043	53	639,504	567,108
	Parks/Landscape	130,680	3.00	0.005	10	13,068	117,612
	Major Road	627,264	14.40	0.023	100	627,264	0
N3	Total N3	544,500	12.50	0.020	6.4	34,848	509,652
	Parks/Landscape	348,480	8.00	0.013	10	34,848	313,632
	Open Space	196,020	4.50	0.007	0	0	196,020
N4	Dallas Ranch Road	121,968	2.80	0.004	40	48,787	73,181
N5	Open Space	135,036	3.10	0.005	0	0	135,036
Storm	Stormwater Facilities	555,473	12.75	0	100	555,473	0
TOTAL	**DMA 4**	**8,783,957**	**201.65**	**0.315**	**44**	**3,880,233**	**4,903,723**

Table 5. Summary of Southern DMA 5

Name	Surface Type	Area			Impervious		Pervious
		sq-ft	*acres*	*sq-mi*	*%*	*sq-ft*	*sq-ft*
S1	Total S1	5,645,376	129.60	0.203	48	2,703,551	2,941,825
	Low Density Residential	1,485,396	34.10	0.053	35	519,889	965,507
	Parks/Landscape	252,648	5.80	0.009	10	25,265	227,383
	Open Space	213,444	4.90	0.008	0	0	213,444
	Major Road	426,888	9.80	0.015	100	426,888	0
	Active Adult (medium density)	3,267,000	75.00	0.117	53	1,731,510	1,535,490
S2	Open Space	3,606,768	82.80	0.129	0	0	3,606,768
S3	Open Space	1,620,432	37.20	0.058	0	0	1,620,432
S4	Open Space (Future Development)	1,546,380	35.50	0.055	0	0	1,546,380
Storm	Stormwater Facilities	406,654	9.34	0.015	100	406,654	0
TOTAL	**DMA 5**	**12,825,610**	**294.44**	**0.460**	**24**	**3,110,206**	**9,715,405**

IV.A.2. Drainage Management Area Descriptions

A description of the DMAs and the drainage paths in provided below, while Exhibit 2 provides a map of the DMAs, without the impervious and pervious area separations.

DMA 1, totaling 624,611 square feet, encompasses the area designated O1, and includes the low-density residential areas at the very northeastern corner of the project. Total impervious cover within this DMA (excluding the IMPs) is 47 percent.[3] DMA 1 drains to the combined IMP 1-2 proposed for an area immediately west of Deer Valley Road. Note that this area is labelled "O1" on Exhibit 2 and includes minor subsequent revisions to the land use areas.

DMA 2, totaling 493,065 square feet**,** including the medium-density residential areas to the south of DMA 1. Total impervious cover within this DMA is 63 percent. DMA 2 drains to the combined IMP 1-2 proposed for an area immediately west of Deer Valley Road. Note that this area is labelled "O2" on Exhibit 2.

DMA 3, totaling 25,037 square feet, includes a portion of roadway that cannot be connected to other IMPs due to elevation constraints. Total impervious cover within this DMA is 83 percent. DMA 3 drains to the IMP 3 proposed for an area immediately west of Deer Valley Road. Note that this area is labelled "O3" on Exhibit 2.

DMA 4, totaling 8,783,957 square feet, encompasses the areas designated N1, N2, N3, N4, and N5 on Exhibit 2. Development within these areas includes both low- and medium-density residential areas as well as parks, open space, and the aforementioned portion of the existing Dallas Ranch Road that drains into the project. Total impervious cover within this DMA is 40 percent, excluding the area of the associated IMP. DMA 4 drains to the IMP 4, a large multi-function stormwater basin that will be constructed north of Sand Creek.

DMA 5, totaling 12,825,610 square feet, encompasses the areas designated S1, S2, S3, and S4 on Exhibit 2. Development within these areas includes low-density residential and active adult areas as well as parks and open space. Total impervious cover within this DMA is 22 percent, excluding the area of the associated IMP. DMA 5 drains to the IMP 5, a large multi-function stormwater basin that will be constructed south of Sand Creek. It is important to note that essentially all of the areas called out as S3 and S4 open space lie outside of the property boundary but drain towards the project and will be collected by the project storm drain system.

The project also includes several areas that are not given DMA designations per se. These include all areas within the protected Sand Creek corridor as well as the Village Center and future fire station locations (the latter two appear with designations "O3" and "O4" on Exhibit 2). These areas are considered self-treating either because there will no development (Sand Creek corridor) or because they will be developed separately and will provide yet-to-be-designed stormwater control measures.

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[3] Percent impervious based on development taken from CCCFCD Standard Runoff Coefficients for the Rational Method. Low Density Residential is R-20 zoning, and Med-Low Density Residential is R-50 zoning.

IV.B. Integrated Management Practice Descriptions

IV.B.1. *Areas Draining to Non-LID Treatment*

There are no areas draining to non-LID treatment.

IV.C. Tabulation and Sizing Calculations

Sizing calculations using the C.3 IMP Calculator are included as an attachment to this plan. Several of the IMPs, particularly IMP 4 and 5 were, previously preliminarily designed for larger overall contributing drainage areas. The IMP calculator results therefore show these features to be significantly over-sized per the facility footprints shown on the exhibits. Where appropriate the facility sizes will be optimized during final design, naturally with continued compliance with all pertinent water quality, hydromodification, and peak flow requirements.

IMP 1-2 is a double-bay cistern + bioretention stormwater facility that is proposed for the northeast corner of the overall project. It will accommodate runoff from DMAs 1 and 2. Per the IMP Calculator the minimum required storage volume for the detention bay ("cistern") is 122,173 cubic feet. This compares to a preliminary proposed volume of 122,885 cubic feet. The IMP Calculator indicates that the minimum floor area for the bioretention bay is 7,631 square feet, while the preliminary proposed floor area is 9,402 square feet. The facility will include an orifice to restrict outflow from the detention bay to the bioretention bay such that flow control is achieved for hydromodification management in addition to full water-quality treatment via bioretention and full trash capture as well. IMP 1-2 will be connected to the existing 36-inch trunk storm drain that runs east from Deer Valley Road along the alignment of Wellness Way.

IMP 3 is a double-bay cistern + bioretention stormwater facility that is proposed adjacent to Deer Valley Road and south of IMP 1-2. It will accommodate runoff from DMA 3. Per the IMP Calculator the minimum required storage volume for the detention bay ("cistern") is 4,228 cubic feet. This compares to a preliminary proposed volume of 4,251 cubic feet. The IMP Calculator indicates that the minimum floor area for the bioretention bay is 264 square feet, while the preliminary proposed floor area is 310 square feet. The facility will include an orifice to restrict outflow from the detention bay to the bioretention bay such that flow control is achieved for hydromodification management in addition to full water-quality treatment via bioretention and full trash capture as well. IMP 3 will also be connected to the existing 36-inch trunk storm drain that runs east from Deer Valley Road along the alignment of Wellness Way.

IMP 4 is a double-bay cistern + bioretention stormwater facility that is proposed along the southern property boundary north of Sand Creek. It will accommodate runoff from DMA 4. Per the IMP Calculator the minimum required storage volume for the detention bay ("cistern") is 799,416 cubic feet. This compares to a preliminary proposed volume of 805,491 cubic feet. The IMP Calculator indicates that the minimum floor area for the bioretention bay is 49,929 square feet, while the preliminary proposed floor area is 72,719 square feet. The facility will include an orifice to restrict outflow from the detention bay to the bioretention bay such that flow control is achieved for hydromodification management in addition to full water-quality treatment via bioretention and full trash capture as well. IMP 4 will drain via a new outfall to Sand Creek.

IMP 5 is a double-bay cistern + bioretention stormwater facility that is proposed adjacent to the Sand Creek corridor directly south of the creek. It will accommodate runoff from DMA 4. Per the IMP Calculator the minimum required storage volume for the detention bay ("cistern") is 1,009,280 cubic feet. This compares to a preliminary proposed volume of 1,013,579 cubic feet. The IMP Calculator indicates that the minimum floor area for the bioretention bay is 63,037 square feet, while the preliminary proposed floor area is 65,310 square feet. The facility will include an orifice to restrict outflow from the detention bay to the bioretention bay such that flow control is achieved for hydromodification management in addition to full water-quality treatment via bioretention and full trash capture as well. IMP 5 will drain via a new outfall to Sand Creek on the south bank of the creek.

V. SOURCE CONTROL MEASURES

V.A. Site activities and potential sources of pollutants

Control of pollutant sources limits the release of pollutants into the stormwater system and serves an important early role in reducing urban pollutants. The Project has the following potential sources of stormwater pollutants:

- Dumping of wash water or other pollutants into storm drain inlets;
- Pesticides used for indoor or structural pest control;
- Fertilizer, pesticide and herbicides use for maintenance of parks, and residential yards and gardens;
- Nutrient loading from household pets;
- Vehicle washing;
- Other vehicle related pollutants such as heavy metals, oil and grease; and
- Plazas, sidewalks and parking lots.

V.B. Source Control Table

Table 6. Source Controls (see next page)

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*
On-site dumping into storm drain inlets	All accessible inlets will be marked with the words "No Dumping! Drains to Sand Creek" or similar wording.	Markings will be periodically repainted or replaced. Inlets and pipes conveying stormwater to all IMPs will be inspected and maintained as part of the Project Operations and Maintenance Plan. Provide stormwater pollution prevention information to new site homeowners.
Indoor and structural pest control		Provide Integrated Pest Management (IPM) information to owners, lessees, and operators.
Landscape / outdoor pesticide use	Preserve existing native trees, shrubs, and ground cover to the maximum extent possible. Minimize irrigation and runoff and promote infiltration where appropriate. Minimize the use of fertilizers and pesticides. Use pest-resistant plants, especially adjacent to hardscape, when possible. Use plantings appropriate to the site soils, slopes, climate, sun, wind land use, air movement, ecological consistency, and plant interactions.	
Vehicle washing		Stormwater pollution prevention information will be distributed to homeowners.
Roofing, gutters, and trim	Do not utilize roofing, gutter, or architectural trim materials made of copper or other unprotected metals that would leach into the storm water runoff.	
Private Drive and Sidewalks		Owners, lessees, and operators will be encouraged to sweep sidewalks regularly to prevent the accumulation of litter and debris. Debris from pressure washing shall be collected to prevent entry into the storm drain system. Wash water containing any cleaning agent or degreaser shall be collected and discharged to the sanitary sewer and not discharged to a storm drain.
Fire Sprinkler Test Water	Provide means to drain fire sprinkler test water to sanitary sewer system.	See note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com
Air Conditioning	Air conditioner condensation shall be directed to landscaped areas or plumbed to the sanitary sewer.	
Plazas, sidewalks, and parking lots		Sweep plazas, sidewalks, and parking lots regularly to prevent accumulation of litter and debris. Collect debris from pressure washing to prevent entry into the storm drain system. Collect wash water containing any cleaning agent or degreaser and discharge to the sanitary sewer not to a storm draining to prevent entry into the storm drain system.

V.C. Features, Materials, and Methods of Construction of Source Control BMPs

Regular monitoring and maintenance are integral to the successful implementation of this Stormwater Control Plan. This includes programmed and documented inspection of all facilities described herein and the prompt remedy of any defects identified.

VI. STORMWATER FACILITY MAINTENANCE

VI.A. Ownership and Responsibility for Maintenance in Perpetuity

The stormwater management facilities identified in this SCP will be owned and managed by the future homeowners' association (HOA).

The HOA will provide a comprehensive Stormwater Control Operations and Maintenance Plan (OMP) to the City and County for review and approval prior to the issuance of any building permits. This will also be contingent on the recording of the pertinent Operations and Maintenance Agreements and rights-of-way necessary to clarify the responsibilities and procedures to be followed over the both the near- and long-term.

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

A full enumeration of O&M requirements will be provided in the OMP discussed above, which will include specific checklists covering all monitoring and maintenance activities associated with the ongoing functionality of the IMPs for both treatment and flow control.

- Proper maintenance of bioretention facilities will include such actions as:
- Regular inspection of the physical features in each basin including inlet and outlet structures, trash racks, side slopes, and access ramps.
- Monitoring of water drawdown rates to verify proper infiltration through the bioretention medium.
- Remedial maintenance including replacement/leveling of mulch, reconditioning/replacement of the biofiltration medium, and clean-out of underdrain piping.
- Regular inspection of maintenance of vegetation, including pruning, replanting as needed, and control of non-desired species.

VII. CONSTRUCTION PLAN C.3 CHECKLIST

As of the date of this report, only preliminary permitting plans have been generated for this project.

VIII. CERTIFICATIONS

The selection, sizing, and preliminary design of stormwater treatment and other control measures in this plan meet the requirements of Regional Water Quality Control Board Order R2-2015-0049.

August 23, 2019

By

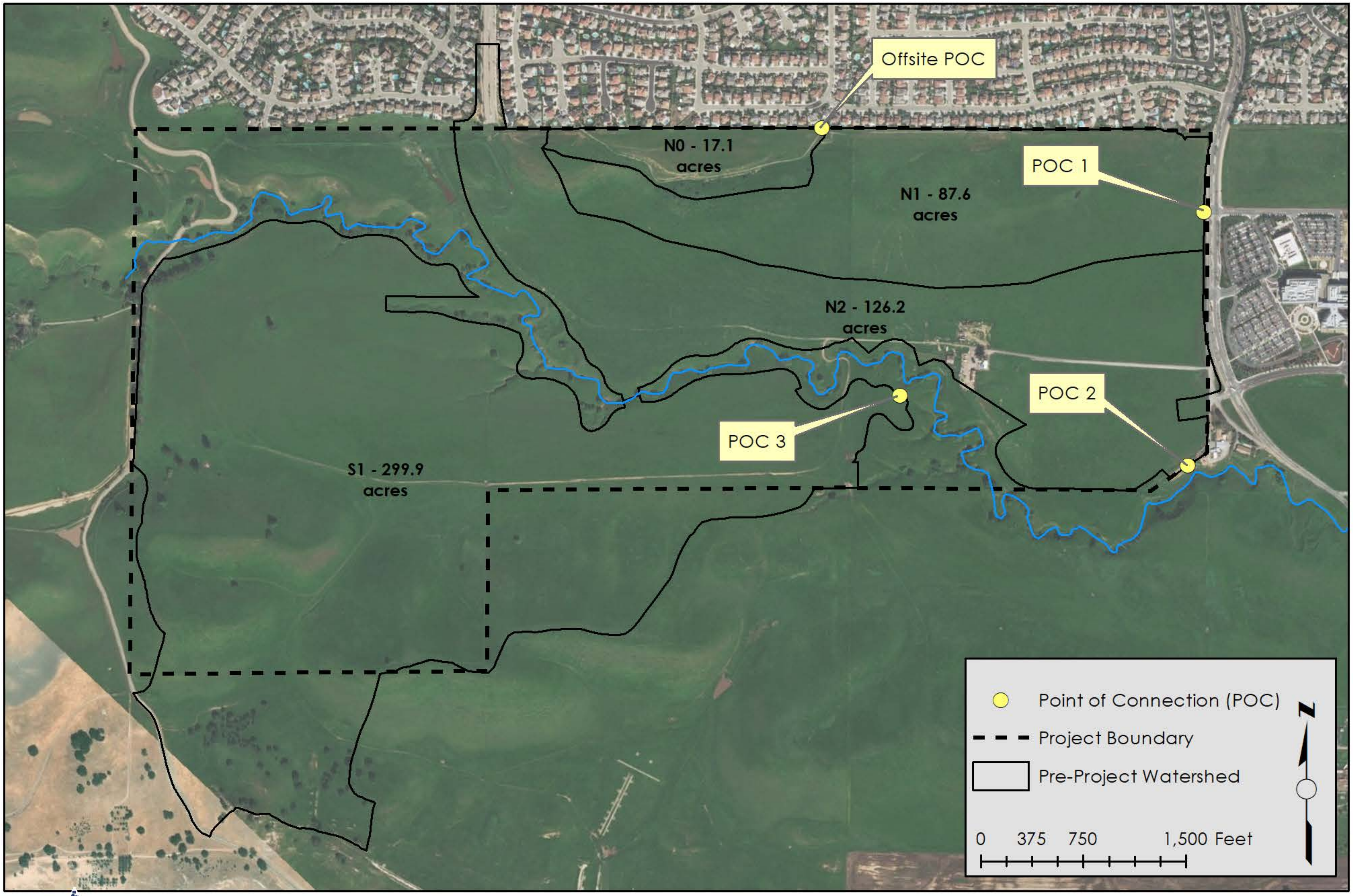
Edward D. Ballman, P.E.

RCE #64095

ATTACHMENTS

ATTACHMENT 1

Stormwater Control Plan Exhibits



Balance Hydrologics, Inc.

Exhibit 1. Pre-Project Hydrology Sheds, The Ranch, City of Antioch, Contra Costa County, California

AREA SUMMARY

SUB AREA	AREA (ACRES)	LAND USE
N1	125.4	LDR, PARKS/LS, OPEN SPACE, MAJOR ROADWAY
N2	45.1	MDR, PARKS/LS, MAJOR ROADWAY
N3	12.5	PARKS/LS, OPEN SPACE
N4	2.8	EXISTING ROADWAY
N5	3.1	OPEN SPACE
TOTAL	188.9	
S1	129.6	LDR, AA, PARKS/LS, OPEN SPACE, MAJOR ROADWAY
S2	82.8	OPEN SPACE
S3	37.2	OPEN SPACE
S4	35.5	OPEN SPACE
TOTAL	285.1	
O1	14.9	LDR, MAJOR ROADWAY
O2	11.3	MDR, MAJOR ROADWAY
O3	0.6	ROADWAY
O4	5.0	VILLAGE CENTER
O5	2.0	FIRE STATION
TOTAL	33.8	

EXHIBIT 2
HYDROLOGY SHED BOUNDARY EXHIBIT

COWAN PROPERTY

CITY OF ANTIOCH CONTRA COSTA COUNTY CALIFORNIA

0' 300' 900' 1,200'

SCALE: 1" = 300' DATE: SEPTEMBER 5, 2019

cbg
CIVIL ENGINEERS • SURVEYORS • PLANNERS

SAN RAMON • (925) 866-0322
SACRAMENTO • (916) 375-1877
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G:\1133-020\ACAD\EXHIBITS\XB_003_HYDROLOGY SHED BOUNDARY_REV5.DWG

ATTACHMENT 2

IMP Sizing Calculator Output

IMP Name: IMP 1-2 (Soil Type: C)
IMP Type: Cistern + Bioretention Facility
Soil Type: C

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
DMA 1-2_Imp	657,240	Concrete or Asphalt	1	657,240
DMA 1-2_Perv	578,956	Landscape	0.5	289,478
			Total	946,718

IMP Sizing

	IMP Sizing Factor	Rain Adjust-ment Factor	Minimum Area or Volume	Proposed Area or Volume
Area	0.013	0.614	7,552	9,402
Volume	0.105	1.216	120,910	122,885

Maximum Underdrain Flow (cfs)	1.08
Orifice Diameter (in)	4.68

IMP Name: IMP 3 (Soil Type: C)
IMP Type: Cistern + Bioretention Facility
Soil Type: C

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
DMA 3_Imp	30,954	Concrete or Asphalt	1	30,954
DMA 3_Perv	4,308	Landscape	0.5	2,154
			Total	33,108

IMP Sizing

	IMP Sizing Factor	Rain Adjust-ment Factor	Minimum Area or Volume	Proposed Area or Volume
Area	0.013	0.614	264	310
Volume	0.105	1.216	4,228	4,251

Maximum Underdrain Flow (cfs)	0.03
Orifice Diameter (in)	0.94

IMP Name: IMP 4 (Soil Type: C)
IMP Type: Cistern + Bioretention Facility
Soil Type: C

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
North_Imp	3,807,514	Concrete or Asphalt	1	3,807,514
North_Perv	4,903,723	Landscape	0.5	2,451,862
			Total	6,259,376

IMP Sizing

	IMP Sizing Factor	Rain Adjust-ment Factor	Minimum Area or Volume	Proposed Area or Volume
Area	0.013	0.614	49,929	72,719
Volume	0.105	1.216	799,416	805,491

Maximum Underdrain Flow (cfs)	7.59
Orifice Diameter (in)	10.45

IMP Name: IMP 5 (Soil Type: C)
IMP Type: Cistern + Bioretention Facility
Soil Type: C

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
South_Imp	3,044,896	Concrete or Asphalt	1	3,044,896
South_Perv	9,715,405	Landscape	0.5	4,857,703
			Total	7,902,599

IMP Sizing

	IMP Sizing Factor	Rain Adjust-ment Factor	Minimum Area or Volume	Proposed Area or Volume
Area	0.013	0.614	63,037	65,310
Volume	0.105	1.216	1,009,280	1,013,579

Maximum Underdrain Flow (cfs)	11.12
Orifice Diameter (in)	12.65

APPENDICES

APPENDIX A

Soil Report

United States Department of Agriculture

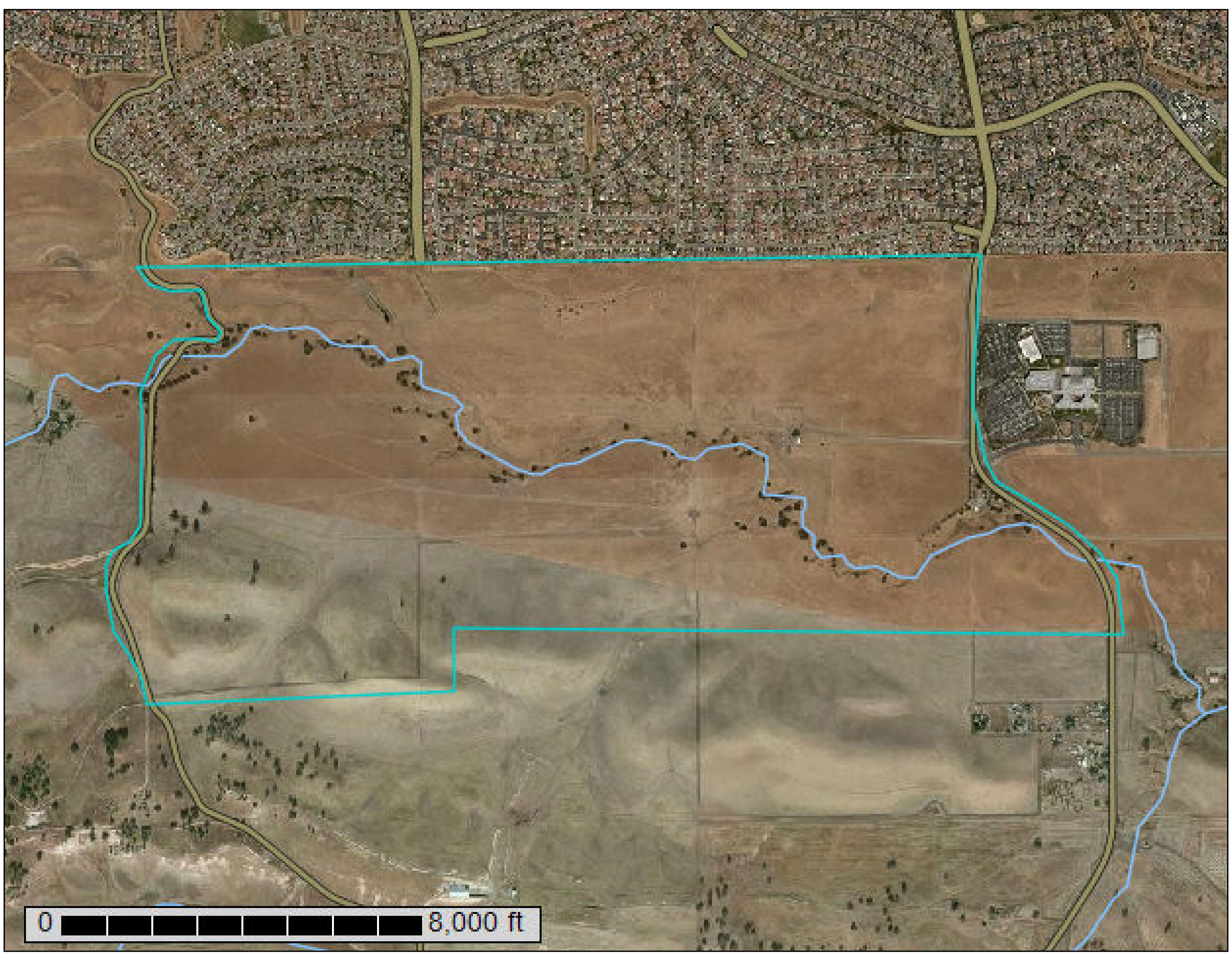
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Contra Costa County, California



May 19, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:16,200 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

N

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

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.

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: Contra Costa County, California
Survey Area Data: Version 13, Sep 21, 2016

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

Date(s) aerial images were photographed: May 12, 2010—Jun 3, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Contra Costa County, California (CA013)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AbD	Altamont clay, 9 to 15 percent slopes, MLRA 15	101.5	14.2%
AbE	Altamont clay, 15 to 30 percent slopes, MLRA 15	119.5	16.7%
AcF	Altamont-Fontana complex, 30 to 50 percent slopes	44.7	6.2%
BdE	Briones loamy sand, 5 to 30 percent slopes	8.9	1.2%
CaA	Capay clay, 0 to 2 percent slopes	245.7	34.3%
Cc	Clear Lake clay, 0 to 15 percent slopes, MLRA 15	0.1	0.0%
RbA	Rincon clay loam, 0 to 2 percent slopes, MLRA 14	196.0	27.4%
Totals for Area of Interest		**716.4**	**100.0%**

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

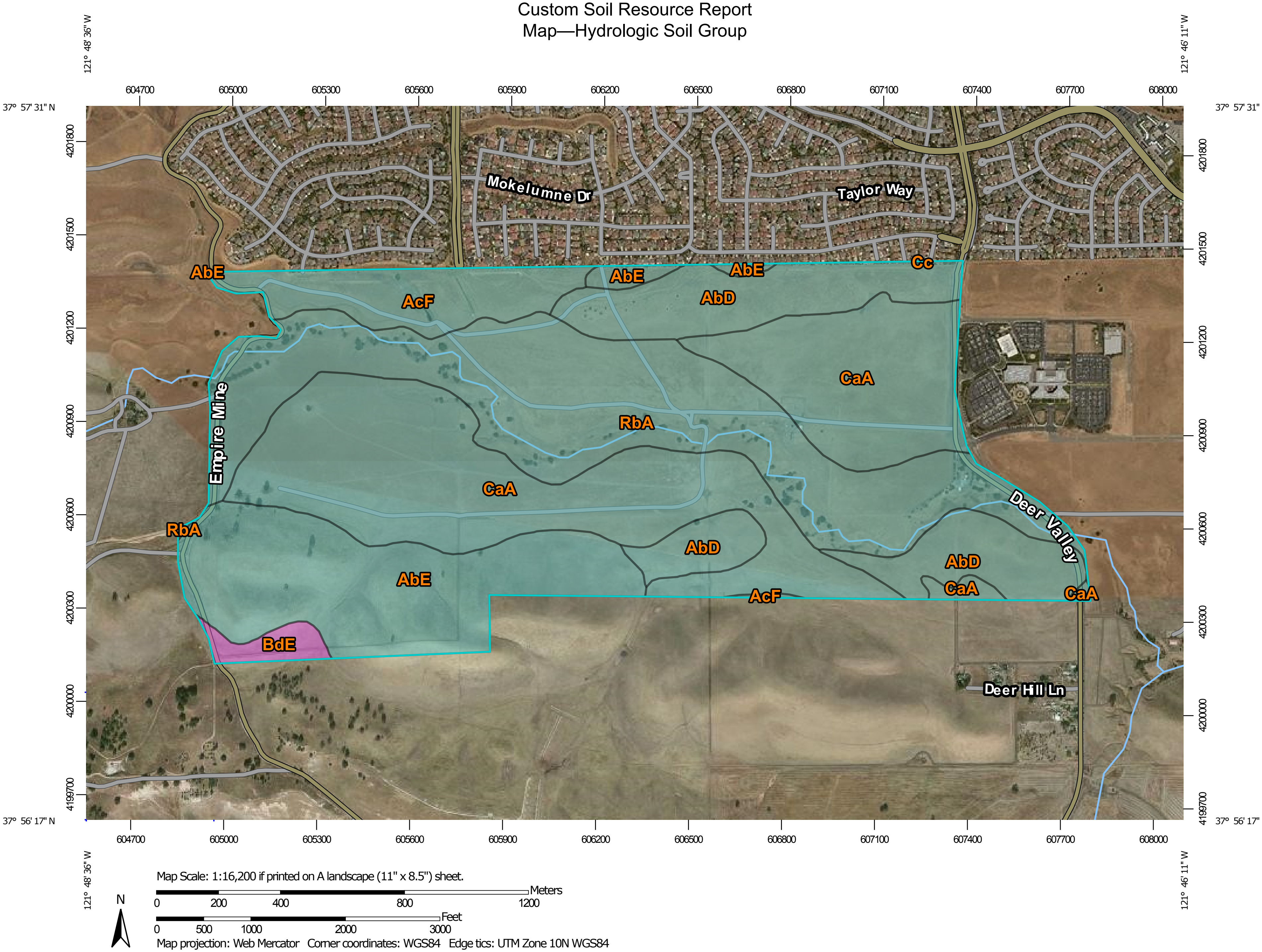
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Map—Hydrologic Soil Group



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

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Web Soil Survey URL:
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Date(s) aerial images were photographed: May 12, 2010—Jun 3, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Contra Costa County, California (CA013)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
AbD	Altamont clay, 9 to 15 percent slopes, MLRA 15	C	101.5	14.2%
AbE	Altamont clay, 15 to 30 percent slopes, MLRA 15	C	119.5	16.7%
AcF	Altamont-Fontana complex, 30 to 50 percent slopes	C	44.7	6.2%
BdE	Briones loamy sand, 5 to 30 percent slopes	A	8.9	1.2%
CaA	Capay clay, 0 to 2 percent slopes	C	245.7	34.3%
Cc	Clear Lake clay, 0 to 15 percent slopes, MLRA 15	C	0.1	0.0%
RbA	Rincon clay loam, 0 to 2 percent slopes, MLRA 14	C	196.0	27.4%
Totals for Area of Interest			**716.4**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

APPENDIX B

Peak Flow Management (Flood Control)

Regional Flood Control Perspective

Historically, the land use in the Marsh Creek and Sand Creek watershed has been predominantly orchards, cattle ranching and dryland farming. The rapid urbanization of the surrounding cities has generated a need to manage the flood risk for locations in east Contra Costa County.

The Contra Costa Flood Control and Water Conservation District (FCD) developed the Marsh Creek Watershed Plan in 1992, to address and mitigate the flood risks. Part of the Marsh Creek Watershed Plan included the construction of Upper and Lower Sand Creek Basins, expansion of Deer Creek Detention Basin, and expansion of the Marsh Creek Reservoir.

The project site lays with in the FCD's defined Drainage Area 104, which includes the upper portions of the Sand Creek watershed. Sand Creek is the largest tributary in the lower Marsh Creek watershed, as it contributes approximately 15 square miles of drainage to Marsh Creek at the confluence in the City of Brentwood. Two flood control basins were built along the Sand Creek watershed to mitigate for urbanization and reduce flood risks in the downstream Marsh Creek urbanized areas. The Upper and Lower Sand Creek Basins, with the Upper Sand Creek Basin being completed in 2014.

The Upper Sand Creek Basin is located approximately 1.3 miles downstream of the Project. Horse Creek watershed joins upstream of the Upper Sand Creek Basin but downstream of the Project.

The objectives within the flood control element of The Ranch project are to mitigate flow increases to the Upper Sand Creek Basin and avoid adverse impacts to peak flow levels at points of discharge from the project. To ensure that flows into Upper Sand Creek Basin are not impacted, the project will include on-site stormwater facilities (IMPs) that will have capacities and outlet works to assure that post-development flows are less than or equal to the pre-development flows, for FCD design storm events ranging from the 10- to the 100-year storm. The peak flows in Sand Creek were also modeled to assess the water surface elevations to inform the design of stormwater outfalls and bridges that are proposed over the course of full build-out.

Sand Creek Peak Flows

The presence of Upper Sand Creek Basin will provide significant flood control for the areas downstream of that facility. However, it is fully-appropriate for the project to control peak flow rates to avoid adverse impacts in the reach of the creek down to the Upper Sand Creek Basin. To aid in identifying appropriate elevations for infrastructure along the creek and to characterize flood risk, a hydraulic model was completed. Peak flows in Sand Creek were estimated from review of historical documentation on the watershed and Upper Sand Creek Basin[1,2].

From the Hydrology and Hydraulic report for the Sand Creek watershed, the flows to the Upper Sand Creek Basin include a drainage area of 11.0 square miles and produce a peak flow of 2,818 cfs for the 100-year, 12-hour storm. Although the project site is located over 3,400 feet upstream of the Upper Sand Creek Basin, the full peak flow values for the USCB were used to represent a conservative modeling approach. The 10-year and 2-year flows were provided by Contra Costa Flood Control as the results in the Hydrology and Hydraulics, Sand Creek Watershed Report. The watershed identified as "Area A thru C" was used to represent the flows at the Project. From the modeling results provided, the 10-year, 12-hour flow is estimated to be 1,430 cfs, and the 2-year, 3-hour flows is estimated as 360 cfs.

Water surface elevations were calculated for the reach encompassing the proposed discharge locations for each of the stormwater basins. The peak flows described above were applied to the channel cross sections to estimate the associated water surface elevation. To calculate the water surface elevations the Army Corps of Engineers' HEC-RAS modeling platform was utilized. The modeling inputs and methodology used in the simulation of peak flows in Sand Creek are further described in the memorandum prepared by Balance Hydrologics and attached herein as Appendix C.

The results from the Sand Creek peak hydraulic modeling analysis indicate that the flows in Sand Creek will be well contained within the banks of the highly-incised stream corridor. This also corroborates the currently-effective floodplain mapping prepared by the Federal Emergency Management Agency, which shows the 100-year flood event contained within the channel. The calculated water surface elevations were used to identify appropriate basin floor elevations for the adjacent stormwater basins. The results of the HEC-RAS modeling are presented in Table B-1 below.

---

[1] GEI Consultants, 2010, Upper Sand Creek Detention Basin Design Report. Contra Costa County Flood Conservation District.

[2] Contra Costa County Flood Control, 2008, Hydrology and Hydraulics, Sand Creek Watershed, Study of Upper Sand Creek Basin, Lower Sand Creek Basin, and Sand Creek Hydraulics

Table B-1. Sand Creek Water Surface Elevation Modeling Results.

Storm Event	Flow	Parameter	Outfall Location IMP 5	Outfall Location IMP4
	(cfs)		*(ft)*	*(ft)*
100 year -12 hour	2,818	Calculated Water Depth (ft)	13.2	14.2
		Water Surface Elevation	230.0	225.2
10 year -12 hour	1,430	Calculated Water Depth	10.2	10.0
		Water Surface Elevation	227.0	221.0
2 year -3 hour	360	Calculated Water Depth	5.4	4.7
		Water Surface Elevation	222.2	215.7

Stormwater Peak Flow Attenuation Modeling

The peak flows from pre- and post-development conditions were evaluated to assess the appropriate detention volume to mitigate the increase in runoff that will occur from development of the area. Pre-project drainage areas were defined using the project topographic base and post-project drainage areas corresponded to the DMAs used in the analysis and sizing of the IMPs for water-quality and hydromodification compliance.

Modeling was completed using the U.S. Army Corps of Engineers' HEC-HMS software package parameterized per guidelines prepared by the FCD for the 10-year and 100-year storm design conditions.

Input Parameters and Assumptions

The input parameters used in the storm drain modeling are summarized below:

Project watersheds: Runoff from the project site will be routed to the four multi-purpose stormwater basins as shown in Exhibit 2. These basins will perform both detention and water quality functions and are used to meet the C.3 stormwater requirements for hydromodification. As described above each stormwater facility has two areas separated by an internal berm: a detention bay and a secondary bioretention bay.

Flood control design storms. All storm total and intensity information was based on a mean annual precipitation (MAP) of 14.3 inches per the isohyetal mapping provided by Flood Control. Based on the size of the site the design storms included 10-year and 100-year return period events with durations of 3-, 6-, 12-, and 24-hours. Total design rainfall ranges from 1.17 inches for the 10-year, 3-hour event up to 4.33 inches for the 100-year, 24-hour storm.

Hydrograph routing parameters. Information on the assumed infiltration rates and lag time calculations followed the guidance provided by Flood Control for lag time and S-curve for hydrograph development.

Peak Flow Modeling Results

The HEC-HMS model results are summarized in Table B-2. Important results and findings include the following:

Pre-project peak flow rates. Peak flow rates for the 10-year design storm range from 43.2 cfs at Point of Concentration (PoC) 1 at the existing 36-inch storm drain at Deer Valley Road and Wellness Way to 54.6 cfs for PoC 2 (future IMP4 outfall, N2 on Exhibit 1), and 164.7 cfs for PoC 3 (future IMP 5 outfall, S on Exhibit 1). While the 3-hour design storm produces the highest peaks for the 10-year event, the 24-hour event gives the highest pre-project peaks. These range from 80.1, to 102.3, and 296.5 cfs for the three PoCs.

Peak flow rates with detention. As shown in Table B-2, the various IMPs provide sufficient storage to mitigate post-development flows to well below the pre-development peak flow rates. Since overall runoff volume is so important for peak flow attenuation, the 24-hour design storms are the most conservative in all the post-project cases. For the PoC 1, the modeling showed a reduction in the peak flow rate for the 10-year, 24-hour storm from 41.4 cfs pre-project to 2.9 cfs post-project. The reductions are particularly pronounced for PoCs 2 and 3 where the reductions were from 52.3 to 6.8 cfs and from 158.0 to 10.7 cfs respectively. For the 100-year, 24-hour event flows were reduced from 80.1 to 6.8 for PoC 1, from 102.3 to 33.3 cfs for PoC 2, and from 296.5 to 68.7 cfs for PoC 3.

The large difference in flow rates is due to the fact that each of the IMPs were also sized to provide hydromodification control and the associated storage capacities and outflow restrictions are such that the single event storms are easily accommodated, even when flow through the bioretention media is discounted as per FCD modeling guidelines.

The model results show that the stormwater facilities presented in the preliminary design for the project will adequately address peak flow attenuation for the site.

Table B-2. HEC-HMS Stormwater Detention Modeling Results for The Ranch

	Design Storm	**Peak Discharge at Outlet (cfs)**	
		Pre-Project	Post-project (detained)
POC 1 (IMPs 1-2 and 3)	10-year 3-hour	43.2	0.9
	10-year 24-hour	41.4	2.9
	100-year 3-hour	72.3	2.6
	100-year 24-hour	80.1	6.8
POC 2 (IMP 4)	10-year 3-hour	54.6	4.4
	10-year 24-hour	52.3	6.8
	100-year 3-hour	92.6	5.6
	100-year 24-hour	102.3	33.3
POC 3 (IMP 5)	10-year 3-hour	164.7	9.8
	10-year 24-hour	158.0	10.7
	100-year 3-hour	270.4	41.6
	100-year 24-hour	296.5	68.7

APPENDIX C

Hydraulic Modeling Summary for Sand Creek

Balance Hydrologics

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April 26, 2019

Mr. Andrea Bellanca
Carlson, Barbee & Gibson, Inc.
2633 Camino Ramon, Suite 350
San Ramon, CA 94583

RE: Summary of Hydraulic Modeling along Sand Creek near Cowan Ranch, Antioch, California.

Dear Mr. Andrea Bellanca,

As requested, a hydraulic analysis of the reach of Sand Creek near Cowan Ranch has been completed. The intent of the analysis is to estimate the water surface elevations and channel velocities under the 100-year storm event at three locations for proposed bridge crossings and three locations for proposed stormwater basin outlets.

Modeling Approach and Assumptions

The section of Sand Creek that flows adjacent to the project site is located about 3,400 feet upstream of the Upper Sand Creek detention basin, which is owned and operated by Contra Costa County Flood Control (CCCFC). This 2.8-mile section of Sand Creek has been classified as Zone A by the Federal Emergency Management Agency (FEMA) and shows approximate inundation boundaries for the 100-year water surface elevation. FEMA has performed more detailed studies of Sand Creek from its confluence with Marsh Creek upstream to the Heidon Ranch Road crossing which is located over two miles downstream from the project site. Since no detailed study has been performed along the section of Sand Creek adjacent to the project site, a hydraulic model was prepared to analyze the 100-year water surface elevation and channel velocities. The Army Corps of Engineers' HEC-RAS modeling platform was used to analyze the reach. As with any hydraulic analysis, a number of assumptions were used. Several of the most important are summarized below:

Cross-section geometry. The topographic mapping of the creek section was provided by Carlson, Barbee & Gibson, Inc (CBG). The topographic data covered the project site and analyzed creek section. In total, the 2.8-mile section of Sand Creek includes 95 modeled cross sections with locations indicated on the model workmap as Figure 1.0 through Figure 1.4. All elevation information presented on the workmap and used in the model is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29)[1].

Manning's roughness coefficients. The Manning's roughness coefficients (or 'n' values) were estimated based on observed vegetation cover and channel geometry from a site visit performed on March 15, 2019. High-water mark observations were documented at specific locations along Sand Creek for reference of the hydraulic model parameters. Based on field observations, all cross sections were assigned a uniform 'n' value of 0.045 and 0.04 for the overbank and channel areas, respectively. Representative photographs of the modeled reach are included as Figure 2.

Channel crossing. The existing channel crossings include a 12.5-foot diameter corrugated metal pipe (CMP), a 24-inch diameter steel gas pipeline that daylights about 15 feet above the channel bottom, and a 30-inch thick wooden vehicular bridge. The existing CMP culvert is located at the most downstream end of the modeled creek section and extends about 50 feet underneath Deer Valley Road with concrete wingwalls constructed at both the inlet and outlet. The bottom three feet of the culvert has been completely covered with sediment reducing the effective height of the pipe to 9.5 feet. The existing gas pipeline runs perpendicular to the channel flow at about 15 feet above the channel bottom. The pipeline crossing is supported by a steel support structure with two 7-inch diameter steel poles spaced about 7.5 feet apart. The existing vehicular bridge is constructed from wooden railroad ties that are stacked 30-inches thick from the bridge deck to the bottom chord. It was assumed that the existing wooden bridge will be removed during construction and was therefore not accounted for in the hydraulic model. Representative photographs of the channel crossings used in the hydraulic model are included as Figure 3.

Starting water surface elevation. The downstream boundary condition was defined using a normal depth calculation assuming a slope of 0.00435 based on an average downstream channel gradient.

Flood discharge estimate. The 100-year discharge rate for the modeled section of Sand Creek was determined from the Draft Sand Creek Watershed Hydrology and Hydraulics report prepared by the CCCFC in 2005. The draft report estimates a 100-year discharge rate of 2,818 cubic feet per second (cfs) for the reach of Sand Creek directly upstream of the Upper Sand Creek detention basin. Correspondence with CCCFC on April 4, 2019, confirmed that the 2,818 cfs discharge rate was used as the basis for the final design of the Upper Sand Creek basin. Since the analyzed creek section is located over 3,400 feet upstream of the Upper Sand Creek basin and does not include the 1,240-acre watershed of Horse Valley Creek, this 100-year discharge rate represents a conservative estimate for the modeled reach of Sand Creek. An excerpt of the Draft Sand Creek Watershed Hydrology and Hydraulics report is included as Appendix A.

[1] The reported elevation values are referenced in NGVD 29 for consistency with the existing topography data. To convert elevations to the North American Vertical Datum of 1988 (NAVD 88) at the project site, a correction value of 2.515 feet should be added to the NGVD 29 elevations. (NAVD 88 = NVGD 29 + 2.515').

Modeling Results

The output of the HEC-RAS modeling is included as Appendix B. A tabular summary of the calculated 100-year water surface elevation and channel velocities for the areas of interest is included as Table 1. The proposed bridges are represented by the cross sections located at river stations 2840, 5890, and 9354. These cross sections are placed directly upstream of the proposed bridge locations. The proposed stormwater basin outlets are represented by the cross sections located at river stations 2367, 4583, and 5828. A summary of the modeled water surface elevation and velocities for the areas of interest is included as Table 2.

The middle and upper sections of the modeled reach meander through areas of narrow ravines with near vertical walls reaching heights of more than 80 feet above the channel bed. These areas cause sudden changes in the channel geometry that restrict flow and result in abrupt increases in the channel velocities causing hydraulic jumps to form at distinct locations. These locations can be observed in the model profile view shown in Appendix B.

A sensitivity analysis was performed on the model to assess the variability in water surface elevations and channel velocities with varying Manning 'n' values. The analysis showed that increasing the 'n' values by 20% caused the average channel velocity to decrease by about 6.6% and the average water surface elevation to increase by about 4.0%. In contrast, decreasing the 'n' values by 20% resulted in the average channel velocity increasing by about 8.3% and the water surface elevation decreasing by about 4.2%.

Closing

We appreciate the opportunity to provide this hydraulic analysis for Sand Creek near Cowan Ranch. Do not hesitate to contact us if you have any questions or comments related to the items discussed here.

Sincerely,

BALANCE HYDROLOGICS, Inc.

Josh Alexander, E.I.T.
Engineer/Hydrologist

Teresa Garrison, P.E.
Senior Engineer

Enclosures: Table 1. Summary of HEC-RAS Output for Bridge and Stormwater Basin Outlet Locations, Sand Creek at Cowan Ranch
Figure 1.0 HEC-RAS Workmap Overview
Figure 1.1 HEC-RAS Workmap
Figure 1.2 HEC-RAS Workmap
Figure 1.3 HEC-RAS Workmap
Figure 1.4 HEC-RAS Workmap
Appendix A. Excerpt from the Draft Sand Creek Hydrology and Hydraulics Report
Appendix B. HEC-RAS Output Report