NAPA PIPE

Development Plan

Volume 2

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VOLUME 2

GENERAL PLAN AMENDMENT

Exhibit A.1 - EXHIBIT A TO THE BOARD OF SUPERVISORS JUNE 4, 2013 RESOLUTION NO. 2013-60 - General Plan Amendment:

EXHIBIT A

The text and illustrations in the existing Napa County General Plan are amended as shown below via tracked changes.

A. INTRODUCTION AND SUMMARY

1. p. SV-2, revise the first bullet about the 2008 General Plan Update to read as follows:

    - Re-designated about 230 acres of Industrial land immediately south of the City of Napa as a “Study Area,” indicating the need for additional study to determine the appropriateness of the area for nonindustrial uses. (Approximately 135 acres were subsequently re-designated Napa Pipe Mixed Use.)

2. p. SV-5 – Modify the last paragraph under the “Housing Element” heading to read as follows:

    The 2004 Housing Element Update provided the information and analysis required by statute, identified 14 sites that were zoned for high density multi-family housing, and memorialized agreements with the cities of Napa and American Canyon whereby the two cities accepted some of the County’s state-mandated housing requirements in exchange for annexations and/or other considerations. The Housing Element was the only element that was not updated in the course of the 2008 General Plan Update, and was instead updated in 2009. The 2009 Housing Element Update eliminated three of the sites identified for high density housing in the prior version, and instead identified 20 acres of the approximately 150-acre Napa Pipe site as a location for high-density housing. Subsequent amendments to the Agricultural Preservation & Land Use Element identified a portion of the Napa Pipe site property as the location for high-density housing consistent with the Napa Pipe Mixed Use designation.

B. AGRICULTURAL PRESERVATION & LAND USE ELEMENT

1. p. AG/LU-2 – Revise the table of contents to reference the Napa Pipe Mixed Use policies.

2. p. AG/LU-18 – Revise Policy AG/LU-25 to read as follows:

    The County opposes the creation of new special districts planned to accommodate new residential developments outside existing urbanized areas, except as specified in the Housing Element or as permitted within the Napa Pipe Mixed Use designation.

3. p. AG/LU-21 – Revise the heading preceding Policy AG/LU-36 to read as follows:

    COMMERCIAL, INDUSTRIAL, NAPA PIPE MIXED USE, AND STUDY AREA LAND USE POLICIES

4. p. AG/LU-21 – Add a new Policy AG/LU-41 as follows:

    Notwithstanding any other standard to the contrary, the following standards shall apply to lands designated as Napa Pipe Mixed Use on the Land Use Map of this General Plan. Lands designated Napa Pipe Mixed Use are identified as Assessor’s Parcel Numbers 046-412-005 and 046-412-005, with the exception of a 19 acre area within Assessor's Parcel Number 046-400-030, which is designated Study Area.

GENERAL PLAN AMENDMENT

a) Intent: The designation provides for flexibility in the development of land, allowing either industrial, or commercial and residential uses. This designation is intended to be applied only to the Napa Pipe site in the unincorporated area south of the city of Napa where sufficient infrastructure may be available or readily constructed to support this type of development.

b) General Uses: Uses allowed in the Urban Residential, Commercial, and Industrial land use categories may be permitted. Office, open space and recreational uses may also be permitted as principal uses.

c) Minimum Parcel Size: Parcel sizes shall be as set forth in an approved development plan for the Napa Pipe Mixed Use designation, provided that the County shall allow 202 owner-occupied or rental units by right pursuant to Housing Element Program H-4e.

d) Maximum Residential Density: No more than 700 total dwelling units (945 with state required density bonus) shall be allowed within the Napa Pipe Mixed Use designation, with an estimated population of 1,540 (or 2,079) persons.

e) Maximum Non-Residential Building Density: No more than a total gross floor area of 319,000 gross square feet of enclosed non-residential uses shall be allowed east of the railroad track within the Napa Pipe Mixed Use designation. No more than 50,000 square feet of enclosed non-residential uses shall be allowed west of the railroad track within the Napa Pipe Mixed Use designation. In addition, on the parcel west of the railroad track, one hotel with no more than 150 suites and associated uses such as meeting space and spa, and up to 150 total units within continuing care retirement and assisted living or similar special use facilities for seniors shall be permitted, and shall not be included in the calculation of total gross floor area or total dwelling units.

5. p. AG/LU-28 – Revise Policy AG/LU-52 as follows:

The following standards shall apply to lands designated as Study Area on the Land Use Map of this General Plan.

Intent: This designation allows industrial uses to continue pursuant to existing zoning, but signals the need for further site- or area-specific planning to assess the potential for a mix of uses in this area. The Study Area designation is intended to be applied only to the portion of the Napa Pipe site that is not designated Napa Pipe Mixed Use and to the Boca/Pacific Coast parcels in the unincorporated area south of the City of Napa, where sufficient infrastructure may be available to support mixed-use development.

General Uses: All uses allowed in the Industrial land use category may be permitted.

Minimum Parcel Size: Parcel sizes shall be as established for the Industrial designation.

Maximum Building Density: Maximum building intensity shall be as established for the Industrial designation.

6. p. AG/LU-52 – Amend the map of South County Industrial Areas to show the new Napa Pipe Mixed-Use designation at Napa Pipe (except on the portion that remains Study Area).

7. p. AG/LU-53 – Modify the paragraph about the Napa Pipe Property as follows:

   Napa Pipe Property – Napa Pipe is an approximately 150-acre site that is proposed for a mixed-use development with a substantial residential component, including affordable housing. Napa Pipe is subject to airport overflights and is bordered by the Napa River, wetlands, and the Napa Valley Corporate Park (in the City of Napa). The site is accessible via Kaiser Road and Napa Valley Corporate Drive.

8. p. AG/LU-66 – Modify Table AG/LU-B General Plan & Zoning: For Use in Considering Changes in Zoning, to include the Napa Pipe Mixed Use designation with the following corresponding zoning designations: Napa Pipe Mixed Use Residential Waterfront, Napa Pipe Industrial/Business Park Waterfront, Napa Pipe Industrial/Business Park, and Industrial.

9. p. AG/LU-67 of the General Plan (Figure Ag/LU-3: Land Use Map), show the Napa Pipe Mixed Use designation at Napa Pipe (except on the portion that remains Study Area) and adjust the boundaries of incorporated cities to reflect any annexations that have occurred since the last time the map was revised.

ZONING ORDINANCES

Exhibit B.1 - COUNTY ORDINANCE adopted on June 4, 2013, establishing the Napa Pipe Zoning District:
(Page numbers of original document included for rederence)

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ORDINANCE NO. 1382

AN ORDINANCE OF THE BOARD OF SUPERVISORS OF THE COUNTY OF NAPA, STATE OF CALIFORNIA, ADDING CHAPTER 18.66 TO THE NAPA COUNTY CODE CREATING THE NAPA PIPE ZONING DISTRICT, REZONING ASSESSOR'S PARCEL NO. 046-412-005 AND A PORTION OF APN 046-400-030 WITHIN THE UNINCORPORATED AREA OF THE COUNTY OF NAPA FROM THE INDUSTRIAL:AIRPORT COMPATIBILITY (I:AC) TO THE NAPA PIPE ZONING DISTRICT:AIRPORT COMPATIBILITY (NP:AC), AND SPECIFYING CONDITIONS OF APPROVAL FOR FUTURE DEVELOPMENT IN THE NAPA PIPE ZONING DISTRICT

WHEREAS, the 154 acre former industrial site commonly referred to as Napa Pipe at 1025 Kaiser Road in unincorporated Napa County, commonly referred to as the Napa Pipe site, is currently designated as "Study Area" in the Napa County General Plan and zoned I:AC (Industrial-Airport Compatibility); and

WHEREAS, the site is comprised of two parcels, being APN 046-412-005 and APN 046-400-030; and

WHEREAS, the purpose of this ordinance is to effect the rezoning of all of APN 046-412-005 (+/- 63 acres) and a portion of APN 046-400-030 (+/- 17.5 acres); and

WHEREAS, the balance of APN 046-400-030 (73.5 acres) would not be rezoned at this time, and would retain its current I:AC zoning designation; and

WHEREAS, a development project has been proposed for 80.5 acres of the Napa Pipe site, encompassing the phased development of a high density residential neighborhood containing low-rise and mid-rise housing, public open space, neighborhood-serving retail and restaurants, a hotel, a continuing care retirement community, and office space and a membership warehouse club; and

WHEREAS, rezoning a portion of the Napa Pipe site and amending the Napa County General Plan would set the stage for other project-specific approvals; and

WHEREAS, under the Napa County 2008 General Plan Update, the Napa Pipe site was designated as "Study Area", which required additional site specific planning and a General Plan amendment prior to reuse of the site for anything except uses allowed under the site's industrial zoning; and

WHEREAS, under the Housing Element Update adopted in June 2009, the General Plan was amended to require rezoning of at least 20 acres of the site to allow up to 304 dwellings at densities of 20 dwelling units per acre, with between 152 and 202 of the dwelling units by right, plus open space and neighborhood supporting uses; and

WHEREAS, to the extent specific amendments to the General Plan are necessary for this zoning ordinance to be consistent therewith, in accordance with Chapter 4, Title 7 of the Government Code (commencing with Section 65800), such General Plan amendments are being made concurrently herewith by separate resolution; and

WHEREAS, the Board of Supervisors desires to rezone a portion of the Napa Pipe site to allow for the proposed uses as set forth in this zoning ordinance; and

WHEREAS, by an earlier and separate resolution, the Board has complied with the requirements of the California Environmental Quality Act by considering and certifying the Napa Pipe Final Environmental Impact Report and making required findings; and

WHEREAS, prior to the consideration and adoption of this ordinance, the noticing requirements of County Code Section 18.136.040 were complied with.

NOW, THEREFORE, the Board of Supervisors of the County of Napa, State of California, ordains as follows:

SECTION 1. Section 18.12.010 (Establishment of zoning districts) of Chapter 18.12 (Establishment of Zoning Districts) of the Napa County Code is amended to read in full as follows:

18.12.010 Establishment of zoning districts.

The unincorporated area of the county of Napa is divided into zoning districts, each of which is designated in this section, and each of which is identified for convenience by the letters indicated:

Zoning District	Letters
Agricultural Preserve	AP
Agricultural Watershed	AW
Airport	AV
Commercial Limited	CL
Commercial Neighborhood	CN
Marine Commercial	MC
Industrial	I
Industrial Park	IP
General Industrial	GI
Planned Development	PD
Public Lands	PL
Residential Single	RS
Residential Multiple	RM

Residential Country	RC
Napa Pipe Zoning District	NP
Napa Pipe – Mixed Use Residential Waterfront	NP-MUR-W
Napa Pipe – Industrial/Business Park Waterfront	NP-IBP-W
Napa Pipe – Industrial/Business Park	NP-IBP
Timber Preserve	TP
Combination Zoning Districts:	
Building Site	:B
Airport Compatibility	:AC
Historic Restaurant	:HR
Urban Reserve	:UR
Agricultural Produce Stand	:PS
Skyline Wilderness Park	:SWP
Affordable Housing	:AH

SECTION 2. A new Chapter 18.66 (Napa Pipe Zoning District) is added to Title 18 (Zoning) of the Napa County Code, reading in full as follows:

Chapter 18.66

NP Napa Pipe Zoning District

Sections:

Division I. General

18.66.010 Intent.

A. The Napa Pipe and Napa Pipe principal district classifications are intended to apply in those areas of the county shown as "Napa Pipe" on the zoning map referenced in Section 18.12.020.

B. The Napa Pipe principal districts are intended to:

1. Implement the goals, objectives, and policies of the General Plan;

2. Establish the Napa Pipe district classifications to provide for development standards and specific project approvals, and to facilitate the economical, efficient, and coordinated development of large areas of residential, commercial, or other non-residential zoned lands;

3. Allow deviation from standard zoning district regulations such as setbacks, lot area, lot coverage, and building height, while remaining consistent with design guidelines for the Napa Pipe district classifications that encourage flexibility and creativity in building design and site planning, and promote a higher level of amenities beyond that expected in conventional developments;

4. Provide for orderly development of publicly accessible open space adjacent to and near the Napa River and build-out of required site improvements and infrastructure;

5. Encourage a mix of different dwelling types and a variety of land uses which complement each other and which are compatible with existing and future surrounding uses;

6. Encourage development of a "walkable" neighborhood with high density housing types, limited neighborhood-serving commercial uses and adjoining industrial/business park uses, in a desirable relationship to planned common use space, cultural, recreational and other uses; and,

7. Allow for the development of General Wholesale Sales Commercial Activities (e.g., the development of a Costco) on +/- seventeen and one-half acres designated "NP-IBP" under this ordinance as a means of generating jobs, providing shopping opportunities not currently available to the region, and generating significant sales tax revenue.

8. Provide jobs for Napa County residents and housing for members of the local workforce.

C. The Napa Pipe principal districts are intended to build-out over time consistent with these development standards and specific project approvals, and to accommodate a limited list of possible interim uses prior to build-out.

18.66.020 Establishment and location of Napa Pipe principal zoning districts.

The following principal zoning districts (collectively, the "NP districts") are established for the purpose of implementing the Napa Pipe Project: Napa Pipe – Mixed Use Residential Waterfront (NP-MUR-W), Napa Pipe – Industrial/Business Park Waterfront (NP-IBP-W), and Napa Pipe – Industrial/Business Park (NP-IBP). For purposes of this Chapter 18.66 only, the NP-MUR-W district is referred to herein as the "MUR district," the NP-IBP-W district is referred to herein as the "IBP-W district," and the NP-IBP district is referred to herein as the "IBP district."

18.66.030 Development plan and design guidelines required.

All development and uses within the NP districts shall be in accordance with approved design guidelines adopted in accordance with Section 18.66.320.

Except for the uses specified in Sections 18.66.070, 18.66.150 and 18.66.240, all development and uses within the NP districts shall also be in accordance with an approved development plan adopted in accordance with Section 18.66.320.

A. The design guidelines shall govern landscaping of streets, parks and open spaces, architectural design, signage, lighting, habitat protection measures, and any other requirements necessary to ensure an aesthetically pleasing and livable neighborhood consistent with the development plan.

B. The development plan shall ensure that adequate public facilities, including water, sewer, parks, schools, and other facilities are or will be available to serve the proposed development, without materially adversely affecting the existing public facilities serving surrounding developments.

C. The development plan shall specify the permitted uses of the property, the density or intensity of use, the maximum height and size of proposed buildings, phasing of the development, and provisions for reservation or dedication of land for public purposes.

D. The development plan can be used similar to a specific plan by outlining individualized development standards which provide for the planning of generally large scale projects. The development plan shall include a site plan depicting such elements as topographical features and the general location of structures, land uses, and public and privaterights-of-way. The development plan must include sufficient information, including architectural design, size of facilities, traffic impacts, a circulation plan, and site improvements at a level of detail which allows for the thorough analysis of project impacts and compliance with county standards.

18.66.040 Use limitations.

A. As applied to the NP districts, the provisions of this Chapter 18.66 shall supersede any conflicting provisions of the Napa County zoning code, except as otherwise required by local, State, or Federal law.

B. There shall be a maximum of seven hundred residential dwelling units within the MUR district exclusive of units allowed by density bonuses pursuant to Section 18.107.150 and State law.

C. There shall be a maximum one hundred-fifty unit continuing care retirement complex within the MUR district with an average of one and one-half beds per unit, for a maximum of two hundred twenty-five beds, that provides independent living for seniors with common dining, recreational activities, housekeeping and transportation, as well as assisted care to seniors with mental and physical limitations.

D. There shall be a maximum of forty thousand square feet of gross floor area for all neighborhood services uses, as defined in subsection (E) of Section 18.66.080, within the MUR District.

E. There shall be a maximum of ten thousand square feet of gross floor area for office uses, as defined in subsection (B) of Section 18.66.160, as the primary use within the IBP-W District.

F. There shall be a maximum of one hotel with a maximum of one hundred-fifty rooms within the IBP-W district, with accessory uses for guests and the general public, including such facilities as meeting rooms, spa and fitness center, provided that the entirety of the use shall not exceed the one hundred person per acre average intensity specified in the Airport Land Use Compatibility Plan.

G. There shall be a maximum of fifteen thousand six hundred square feet of community facilities within the MUR or IBP-W districts which may include: transit center, interpretive nature center, boat house, café/visitor pavilion, child care center, and drydock theatre.

H. There shall be a maximum of one hundred fifty-four thousand square feet of General Wholesale Sales Commercial Activities as defined in subsection (A) of Section 18.66.250 within the IBP district.

I. Temporary events and uses may be conducted pursuant to Chapter 5.36 and shall not conflict with Chapter 18.80 or with the Napa County Airport Land Use Compatibility Plan.

J. Interim uses and floor area intended to remain in place for five years or less are subject to separate review and approval by the zoning administrator.

18.66.050 Common use/open space.

A. Not less than fifteen percent of the total area of all NP districts, collectively, shall be devoted to common use/open space that is accessible to the public.

B. The locations of common use/open space shall be specified in the development plan and shall include:

1. Land area not covered by buildings, parking structures or accessory structures except community facilities, including without limitation parks, wetlands, community gardens, yards, planting, walkways, paths, trails, and bridges devoted to pedestrian and bicycle use;

2. Community facilities, defined as indoor or outdoor facilities, not publicly owned but open for public use, in which the chief activity is not a gainful business and whose chief function is the gathering of persons for recreational (including public swimming pool uses), cultural, entertainment, athletic, group assembly, social interaction, or educational purposes (including storage of related materials and equipment), and may also include within such a community facility compatible accessory uses such as restaurants, cafes, sports rental equipment and similar uses;

3. Water bodies and water features, including boat docks, piers, and landings that contribute to the quality, livability and amenity of the NP districts.

C. Common use/open space shall not include:

1. Streets, lanes, and similar roadways;

2. Open parking areas, driveways, and loading facilities;

3. School sites, except that publicly accessible green space and play areas shall be considered common use/open space;

4. Open-air rooftop facilities such as rooftop decks and gardens not available for public use.

D. If common use/open space is deeded to a homeowner's association, such legal instrument may take the form of a declaration of covenants and restrictions.

Division II. Mixed Use Residential - Waterfront Zoning District (NP-MUR-W)

18.66.060 Intent.

The MUR district is characterized by a mix of housing types, neighborhood services such as retail and restaurants, common use/open space including open space, parks, and community facilities. The intent of this district is to enable a vibrant, mixed use neighborhood oriented towards the Napa River.

18.66.070 Uses allowed without a use permit.

The following uses shall be allowed in the NP-MUR-W district without a use permit:

A. Family day care homes (small).

B. Residential care facilities (small).

C. Home occupations subject to the provisions of Section 18.104.090.

D. Homeless and emergency shelters subject to the provisions of Section 18.104.065.

E. Minor antennas meeting the requirements of Sections 18.119.240 through 18.119.260.

F. Telecommunication facilities, other than satellite earth stations, which consist solely of wall-mounted antenna and related interior equipment and meet the performance standards specified in Section 18.119.200, provided that prior to issuance of any building permit, or the commencement of the use if no building permit is required, the director or the director's designee has issued a site plan approval pursuant to Chapter 18.140.

G. Up to a maximum of two hundred-two dwelling units provided for sale or rental in multi-unit buildings constructed at densities of at least twenty dwelling units per acre, provided that the housing is consistent with approved design guidelines and adopted mitigation measures.

H. Any use specified in Section 18.66.080 and which is allowed by an approved development plan.

I. Farmworker housing providing accommodations for six or fewer employees and otherwise consistent with Health and Safety Code Section 17021.5 or successor provisions, subject to the conditions set forth in Sections 18.104.300 and 18.104.310, as applicable.

18.66.080 Uses allowed upon approval of a development plan.

The following uses shall be allowed in the NP-MUR-W district upon approval of a development plan:

A. Attached and detached single-family dwelling units and multiple family dwelling units as defined in Section 18.08.380, provided that at least three hundred four units, including units built pursuant to subsection (G) of Section 18.66.070, are developed at a density of at least twenty units per acre. For purposes of this Chapter 18.66 only, cohousing and dormitory or other student housing are deemed to be included in the definition of multiple family dwelling units. Cohousing and dormitory or other student housing may include, without limit, a common house with a common kitchen, dining area, children's play area, laundry, workshop, library, exercise room, crafts room, guest rooms, and/or other common areas. Timeshare units are not included in the definition of multiple family housing.

B. Child day care center as defined in Section 18.08.130.

C. Common use/open space as defined in Section 18.66.050.

D. Family day care homes as defined in Section 18.08.290, subject to Section 18.104.070.

E. Neighborhood services. Neighborhood services includes neighborhood-serving commercial uses, such as retail sales establishments, pharmacies, personal services establishments (e.g., dry cleaners, hair salons, nail salons, shoe or watch repair stores), physical fitness studios, and any other neighborhood serving non-residential use not expressly prohibited, limited to a maximum floor area of two thousand five hundred square feet. Neighborhood services also includes grocery markets limited to not more than twenty thousand square feet; restaurants and eating establishments, bars, lounges, and nightclubs; and office uses, as defined in subsection (B) of Section 18.66.160, that are located on the second floor and limited to a maximum of one thousand five hundred square feet per office. Allowed neighborhood services do not include businesses with drive-through facilities or any use with an on-site dry cleaning plant. Common use/open space, and commercial recreation facilities shall not be considered neighborhood services uses and are not subject to the use limitations set forth in subsection (D) of Section 18.66.040.

F. Outdoor and indoor commercial recreation.

G. Parking as provided in Sections 18.66.280 et seq.

H. Public safety facilities.

I. Public utility and public service buildings and facilities.

J. Other public facilities, such as post offices, public libraries, museums, and art galleries.

K. Residential care facilities as defined in Section 18.08.540.

L. Senior housing, defined as any residential facility designed to meet the housing and medical needs of senior citizens, including continuum of care facilities, independent living facilities, assisted living facilities, skilled nursing facilities, and similar or related facilities and services subject to the limitations in subsection (C) of Section 18.66.040.

M. Transit stations and terminals.

18.66.090 Density.

Densities in the MUR district shall not exceed twenty dwelling units per acre, except where a density bonus is obtained pursuant to Section 18.107.150. Regardless of permitted densities, the total number of residential units shall not exceed the limitations in Section 18.66.040. Senior housing, as defined in subsection (L) of Section 18.66.080, shall not be included in the calculation of total dwelling units.

18.66.100 Lot size.

Buildable lots in the MUR district shall be a maximum of 2.7 acres. Minimum lot sizes shall be determined as set forth in the development plan.

18.66.110 Height.

A. The maximum height in the NP-MUR-W district shall be fifty-five feet.

B. The height of a structure shall be measured by the vertical distance from grade plane to the average height of the highest roof surface.

C. Exemptions from height limits. The following features shall be exempt from the height limits established by this chapter, subject to limitations indicated:

1. Mechanical equipment and appurtenances necessary to the operation or maintenance of the building or structure itself.

2. Additional building volume used to enclose or screen from view the features listed under subsection (C)(1) above and to provide additional visual interest to the roof of the structure.

3. Railings, parapets and catwalks, with a maximum height of four feet and open railings, catwalks and fire escapes required by law, wherever situated.

4. Unroofed recreation facilities with open fencing, including tennis and basketball courts at roof level, swimming pools with a maximum height of four feet and play equipment with a maximum height of ten feet.

5. Unenclosed seating areas limited to tables, chairs and benches, and related wind screens, lattices and sunshades with a maximum height of ten feet.

6. Landscaping, with a maximum height of four feet for all features other than plant materials.

7. Flag poles and flags, and weather vanes.

8. Cranes, scaffolding and batch plants erected temporarily at active construction sites.

9. Cranes that exist in any of the NP districts at the time of approval of the development plan.

10. Headhouses and/or enclosed roof access.

11. Such other exemptions as are deemed reasonable, necessary, and appropriate by the director.

18.66.120 Building and parking setbacks, landscaping, and lot coverage.

Maximum lot coverage, landscaping, and building setbacks shall be determined as set forth in the development plan and design guidelines.

18.66.130 Uses within enclosed structures.

All operations shall be conducted completely within an enclosed structure, except as follows:

A. Bus stops and transit stations.
B. Common use/open space.
C. Outdoor dining accessory to an approved use.
D. Outdoor recreation uses.
E. Parking and loading.
F. Play areas for child day care centers.
G. Temporary events and uses in accordance with subsection (I) of Section 18.66.040.
H. Other similar uses or activities as determined by the zoning administrator.

Division III. Industrial/Business Park-Waterfront Zoning District (NP-IBP-W)

18.66.140 Intent.

The purpose of the IBP-W district is to provide for office, hotel, and similar uses. Allowed uses in the IBP district are intended to be compatible with each other and with the adjoining nonindustrial areas. Land uses in the IBP district are subject to special performance standards to ensure harmonious, unified and cohesive development that is oriented towards the Napa River.

18.66.150 Uses allowed without a use permit.

The following uses shall be allowed in the IBP-W district without a use permit:

A. Minor antennas meeting the requirements of Sections 18.119.240 through 18.119.260.

B. Telecommunication facilities that meet the performance standards specified in Section 18.119.200, provided that prior to issuance of any building permit or the commencement of the use if no building permit is required, the director or director's designee has issued a site plan approval pursuant to Chapter 18.140.

C. Homeless and emergency shelters subject to the provisions of Section 18.104.065.

D. Any use specified in Section 18.66.160 and which is allowed by an approved development plan.

18.66.160 Uses allowed upon approval of a development plan.

The following uses shall be allowed in the IBP-W district upon approval of a development plan, subject to the limitations of Section 18.66.040:

A. Hotel. One hotel is allowed within the IBP-W district with a maximum of one hundred fifty rooms/suites. A hotel is defined as a facility that offers transient lodging accommodations typically on a daily rate to the general public and that may provide additional services, such as restaurants, conference facilities, and recreational facilities.

B. Office Uses. Office uses include professional, administrative, executive, financial, real estate, insurance and other general business offices, including service businesses such as small financial services, such as branch banks. Office uses also include medical, dental, and optical offices and related accessory laboratories.

C. Common use/open space as defined in Section 18.66.050.

18.66.170 (Reserved.)

18.66.180 Height.

A. The maximum height in the IBP-W district shall be forty-eight feet.

B. The height of a structure shall be measured by the vertical distance from grade plane to the average height of the highest roof surface.

C. Exemptions from height limits. The following features shall be exempt from the height limits established by this Chapter 18.66, subject to limitations indicated:

1. Mechanical equipment and appurtenances necessary to the operation or maintenance of the building or structure itself.

2. Additional building volume used to enclose or screen from view the features listed under subsection (C)(1) above and to provide additional visual interest to the roof of the structure.

3. Railings, parapets and catwalks, with a maximum height of four feet and open railings, catwalks and fire escapes required by law, wherever situated.

4. Unroofed recreation facilities with open fencing, including tennis and basketball courts at roof level, swimming pools with a maximum height of four feet and play equipment with a maximum height of ten feet.

5. Unenclosed seating areas limited to tables, chairs and benches, and related wind screens, lattices and sunshades with a maximum height of ten feet.

6. Landscaping, with a maximum height of four feet for all features other than plant materials.

7. Flag poles and flags, and weather vanes.

8. Cranes, scaffolding and batch plants erected temporarily at active construction sites.

9. Cranes that exist in any of the NP districts at the time of approval of the development plan.

10. Such other exemptions as are deemed reasonable, necessary, and appropriate by the director.

18.66.190 Lot coverage.

Site coverage in the IBP-W district shall be governed by the design guidelines, but in no case shall be more than fifty percent, except as otherwise provided in an approved development plan or use permit.

18.66.200 Lot size.

Buildable lots in the IBP-W district shall be a maximum of twenty acres. Minimum lot sizes shall be determined as set forth in the development plan, provided that the number of curb cuts per block for access to parking shall be limited as specified in the design guidelines.

18.66.210 Landscaping, building and parking setbacks.

Landscaping, building and parking setbacks in the IBP-W district shall be determined as set forth in the development plan and design guidelines.

18.66.220 Uses within enclosed structures.

All operations shall be conducted completely within an enclosed structure, except as follows:

A. Bus stops and transit stations.

B. Common use/open space.

C. Outdoor dining accessory to an approved use.

D. Outdoor recreation uses.

E. Parking and loading.

F. Play areas for child care facilities.

G. Temporary events and uses in accordance with subsection (I) of Section 18.66.040.

H. Vehicle storage yards.

I. (Reserved.)

J. Other similar uses or activities as determined by the director where a use permit is required.

Division IV. Industrial/Business Park Zoning District (NP-IBP)

18.66.230 Intent.

The purpose of the IBP district is to provide for general wholesale sales commercial activities and similar uses. Allowed uses in the IBP district are intended to be compatible with each other and with adjoining areas. Land uses in the IBP district are subject to special performance standards to ensure harmonious, unified and cohesive development.

18.66.240 Uses allowed without a use permit.

The following uses shall be allowed in the IBP district without a use permit: those uses allowed without a use permit in the IBP-W district.

18.66.250 Uses allowed upon approval of a development plan.

The following uses shall be allowed in the IBP district upon approval of a development plan, subject to the limitations of Section 18.66.040:

A. General Wholesale Sales Commercial Activities. General Wholesale Sales Commercial Activities include the storage and sale, from the premises, of bulk goods, as well as the storage of such goods on the premises and their transfer therefrom to other firms or individuals; but exclude sale or storage of motor vehicles, except for parts and accessories, and sale or storage of materials used in construction of buildings or other structures. This classification does not include hardware or paint stores. This classification also excludes the retail sale from the premises of goods and merchandise, primarily for personal or household use, from stores whose total sales floor area exceeds one hundred thousand square feet, and which devote more than ten percent of sales floor area to the sale of non-taxable merchandise, except at stores classified as wholesale clubs, membership warehouse stores, or other similar establishments selling primarily bulk merchandise and charging membership dues or otherwise restricting merchandise sales to customers paying a periodic access fee. Such uses shall not exceed one hundred fifty-four thousand square feet.

18.66.260 Height, lot coverage, lot size, landscaping, setbacks.

In the IBP district, standards governing height, lot coverage, landscaping and setbacks shall be the same as for the IBP-W district as established under sections 18.66.180 through 18.66.210.

18.66.270 Uses within enclosed structures.

All operations shall be conducted completely within an enclosed structure, except as follows:

A. Those uses listed under section 18.66.220.

B. Uses appurtenant to General Wholesale Sales Commercial Activities (e.g., garden centers and gas stations).

Division V. General Standards

18.66.280 Parking.

A. The number of off-street parking spaces required in the MUR, IBP-W and IBP districts shall be as set forth in Table 18.66.280 or in an approved development plan.

Table 18.66.280
Number of parking spaces required.

Use	Parking Spaces required
Residential	
- Studio - 1-bedroom - 2-bedroom - 3-bedroom	1.25/unit 1.5/unit 2.0/unit 2.0/unit
- Senior Housing	1.0 for each unit (includes employees)
- Residential (Guest parking)	1.0 per 4 units
Commercial-Retail	1 per 250 sq. ft.
Restaurants	1 per 120 sq. ft.
Hotel	1 per room (includes employees)
- Conference center	20 per 1,000 sq. ft. of gross floor area
- Food service facilities	included in above

- Retail	included in above
Light Industrial	
- Warehousing/Storage	1 per 1,000 sq. ft. for the first 20,000 sq. ft. and 1 per 2,000 sq. ft. for area exceeding 20,000 sq. ft.
- Office	1 per 250 sq. ft.
- Manufacturing	1 per 500 sq. ft.
- General Wholesale Sales Commercial Activities	1 per 200 sq. ft.

Notes:

- All required parking shall be provided off-street except for residential guest parking which may be provided on-street.
- Parking shall be based on gross floor area where indicated.
- Where the computation of required parking spaces produces a fractional result, fractions of one-third or greater shall require one full parking space.

B. Shared parking arrangements shall be allowed only in accordance with an approved development plan establishing standards for the distance between uses and parking spaces and establishing a maximum number of off-street parking spaces.

C. The location of off-street parking spaces shall be as set forth in an approved development plan. For uses in subsection (D) of Section 18.66.150 or in Section 18.66.240, the location and number of off-street parking spaces shall comply with Section 18.104.065.

18.66.290 Bicycle parking.

Section 18.110.040 shall apply to all non-residential uses in the NP districts.

18.66.300 Off-street freight loading and service vehicle spaces.

Off-street loading and service vehicle requirements shall be in accordance with Sections 18.110.040 through 18.110.060.

18.66.310 Signage.

A. In the MUR district, one monument and one wall-mounted building identification sign is permitted per building. The size, placement, maintenance, and design of the sign shall be consistent with the approved design guidelines.

B. In the IBP-W and IBP districts, signage shall be consistent with Sections 18.116.035 and 18.116.036 and the approved design guidelines.

C. Illumination. No sign shall be illuminated in a manner that would create aviation hazards of any kind, including but not limited to direct skyward projection, glare or mimicry of airport lights. Sign illumination will also be consistent with the approved design guidelines.

D. Street signage shall be consistent with Napa County standards and the approved design guidelines.

Division VI. Reviews and Approvals

18.66. 320 Process for review and approval of development plan and design guidelines.
Within the NP districts, the application and review procedures described in Chapter 18.136 (Zoning Amendment) shall apply to the approval of the development plan and design guidelines.

SECTION 3. In addition to conforming with applicable requirements of the Napa County Code, all development plan approvals submitted under Chapter 18.66 and all subdivision map approvals affecting the Napa Pipe site shall be conditioned to implement mitigation measures as described in the Developers Revised Proposal Project Mitigation Monitoring and Reporting Program adopted by resolution of the Board of Supervisors in Resolution No. 2013-60. In addition, such approvals shall be conditioned to require the following project components, which were described as features of the project upon which the analysis under CEQA was based:

1. Prior to construction, grading Assessor's Parcel Numbers 046-412-005 and 046-400-030, and filling all of APN 046-412-005 and a portion of APN 046-400-030 (+/- 16 acres) to a typical minimum elevation of 12 feet NGVD29 (National Geodetic Vertical Datum of 1929);

2. Construction of the access roads on Assessor's Parcel Number 046-400-030 that are shown on the site plan attached as Exhibit B prior to occupancy, including the bridge to Anselmo Court, and Anselmo Court/Corporate Drive improvements such that all access roads are also at a flood elevation of 12 feet NGVD29;

3. Prior to approval of a development plan, "Will serve" approval from the Napa Sanitation District prior to building construction;

4. Prior to approval of a development plan, "Will serve" approval from the City of Napa or an alternate source for the provision of water, and evidence that groundwater will not be used;

5. Prior to construction on APN 046-412-005, obtaining any necessary Public Utilities Commission approvals, constructing three at grade railroad crossings with floodgates for use in flood events, and approval by the Director of Public Works of a mechanism to provide for flood gate implementation;

6. Phased construction of on-site roadways to the satisfaction of the Department of Public Works, as shown on the Site Plan attached as Exhibit B;

7. Wetland restoration and phased construction of the public trail along the Napa River, the riverfront park, the railroad park and the community subscription farm as shown on the Site Plan attached as Exhibit B, and approval by the Director of Public Works of a mechanism to provide for the maintenance of those facilities;

8. Construction of an at grade trail from the site to Kennedy Park;

9. Concurrence of the Napa County Mosquito Abatement District that adequate access is provided to the site for vehicular access associated with District abatement activities, and the establishment of a funding mechanism sufficient to cover on-site vector control and necessary District abatement activities.

SECTION 4. Approximately 80.5 acres located off 1025 Kaiser Road, approximately 1/3 mile west of Highway 221/Soscol Avenue and ¼ mile north of Highway 29, on Assessor's Parcel Numbers 046-400-030 and 046-412-005 as identified on the on the Official Maps of the Napa County Assessor in effect at the time this ordinance takes effect, and as shown on Exhibit "A" attached hereto and incorporated herein by reference, is hereby rezoned from I:AC (Industrial: Airport Compatibility District) to NP:AC (Napa Pipe Zoning District: Airport Compatibility District) and associated Napa Pipe principal districts, as shown on Exhibit "A."

The official zoning map shall be amended to reflect this change consistent with the requirements of Chapter 18.12.

SECTION 5. The +/- 73.5-acre portion of Assessor's Parcel Number 046-400-030 that is not rezoned NP-IBP, as shown on Attachment "A," shall retain its I:AC (Industrial: Airport Compatibility District) zoning designation.

SECTION 6. The Board further finds that, pursuant Chapter 4, Title 7, commencing with Section 65800, of the California Government Code, this Ordinance is consistent with the following goals, policies and action items of the 2008 General Plan Update and as amended by Resolution concurrent with the adoption of this Ordinance: Goals AG/LU – 2, 3, 5; CIR-1; CC-8; CON-11; H-1; ROS-2; and Policies AG/LU-28, 30, 42, 52, 93, 94, 95, 119; CIR-1, 3, 4, 38; CC-36, 44, 45; E-5, 8; H-2b, 2c, 4a, 4d; ROS-14, 22, 23, 24; and Action Items AG/LU-94.1; and CC-45.1.

SECTION 7. If any section, subsection, sentence, clause, phrase or word of this Ordinance is for any reason held to be invalid by a court of competent jurisdiction, such decision shall not affect the validity of the remaining portions of this ordinance. The Board of Supervisors of the County of Napa hereby declares it would have passed and adopted this Ordinance and each and all provisions hereof irrespective of the fact that any one or more of said provisions be declared invalid.

SECTION 8. This Ordinance shall be effective thirty (30) days from and after the date of its passage.

SECTION 9. A summary of this Ordinance shall be published at least once 5 days before adoption and at least once before the expiration of 15 days after its passage in the Napa

Valley Register, a newspaper of general circulation published in the County of Napa, together with the names of members voting for and against the same.

The foregoing Ordinance was introduced and public hearing held thereon before the Napa County Conservation, Development and Planning Commission at a special meeting of the Commission on the 3rd day of October, 2012, and was passed at a regular meeting of the Board of Supervisors of the County of Napa, State of California, held on the 4th day of June, 2013, by the following vote:

AYES:	SUPERVISORS	DODD, CALDWELL, WAGENKNECHT, LUCE, and DILLON
NOES:	SUPERVISORS	NONE
ABSENT:	SUPERVISORS	NONE

BRAD WAGENKNECHT, Chairman
Napa County Board of Supervisors

ATTEST: GLADYS I. COIL
Clerk of the Board of Supervisors

By: [signature]

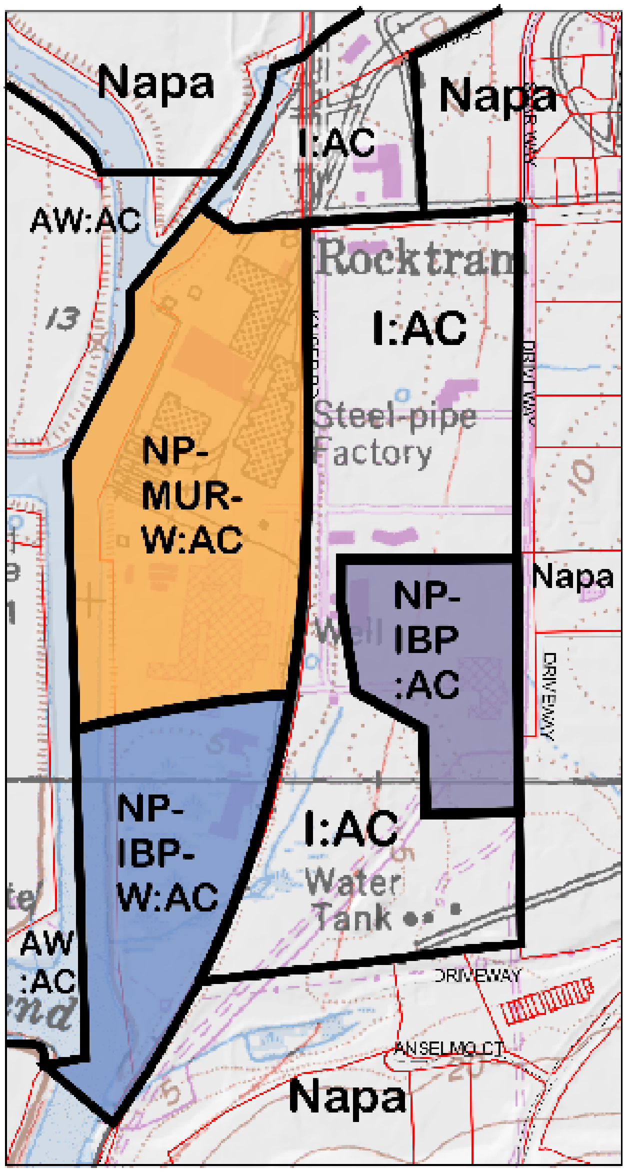
APPROVED AS TO FORM Office of County Counsel	Approved by the Napa County Board of Supervisors
By: Robert W. Paul, (by e-signature) Deputy County Counsel By: *Sue Ingalls*, (by e-signature) County Code Services Date: June 4, 2013	Date: 6/4/2013 Processed by: [signature] Deputy Clerk of the Board

I HEREBY CERTIFY THAT THE ORDINANCE ABOVE WAS POSTED IN THE OFFICE OF THE CLERK OF THE BOARD IN THE ADMINISTRATIVE BUILDING, 1195 THIRD STREET ROOM 310, NAPA, CALIFORNIA ON June 5, 2013.

[signature], DEPUTY
GLADYS I. COIL, CLERK OF THE BOARD

cc/d/pl/N P/DevRevProp/BOS Approval/
BOS Ord.Final(6.4.13)

NAPA PIPE (Exhibit - A)



09-17-2012

Napa County Conservation Development and Planning Department

cc/d/pl/N P/DevRevProp/BOS Approval/
BOS Ord.Final(6.4.13)

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NAPA PIPE (Exhibit - B)

09-17-2012

Napa County Conservation Development and Planning Department

cc/d/pl/N P/DevRevProp/BOS Approval/
BOS Ord.Final(6.4.13)

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GREENHOUSE GAS EMISSION REDUCTION

Baseline analysis was conducted by both Ashworth Leininger Group (ALG) and The Planning Center | DC&E on the current development scenario and the Napa Pipe. These analysis identified the vehicle trips as being a key component to driving the GHG emissions. Specific mitigation measures that were modeled included:

- Mix of uses,
- Local serving retail,
- Transit service,
- Bike and pedestrian access, and
- Affordable housing.

In addition to this planning baseline, a targeted approach to reducing parking requirements has been identified as a key concern by parties such as the Greenbelt Alliance. Therefore, the parking proposal suggests a residential parking strategy that is less than the modelled assumptions, thereby reducing the anticipated GHG emissions.

The project is registered under the LEED-ND standard for development and has achieved a Gold Certification from the USGBC for the site planning. This exercise identified site planning measures that will reduce GHG emissions on the project including: walkable blocks to avoid driving within the development itself, access to public transportation and alternate means of transportation via rail and water, and extensive tree planting along streets for natural shading, to name a few.

Aside from vehicle trips, the model also computes CO_2 emissions from the following sources:

- Electricity,
- Water and wastewater treatment and delivery,
- Solid waste disposal and decay,
- Off-road equipment, and
- Refrigerants.

In order to provide a framework for expanding these GHG emissions from these sources and the during construction (a large source of GHG emissions), the project has established LEED Silver or greater compliance in the construction of new buildings on site, whether this be Residential or Commercial in use. This standard allows for enforcement of a threshold goal, while anticipating the need for alternate approaches depending on the building use and type.

This standard allows the project development to be held to a standard that exceeds the modelled assumptions and includes suggested mitigation measures for the Napa Pipe project including:

- Incorporate on-site renewable energy systems,
- Increase in energy efficiency to a minimum of 20% beyond Title 24 requirements project-wide,
- Drought tolerant landscaping,
- Low flush toilets,
- Solid Waste reduction equivalent to 50% below business as usual conditions.
- Use of ‘white’ or light colored roofing

Suggested mitigation measure from GHG-1c for reference:

GHG-1c: As a means of reducing global warming related impacts of a project, the project applicant shall incorporate additional measures to reduce the project’s contribution to the county-wide GHG emissions associated with development assumed under the County’s General Plan. Such measures shall include the following additional items from the California Attorney General’s Office (2008) list of suggested measures for reducing global warming related impacts of a project:

Energy Efficiency

- Design buildings to meet LEED certification requirements applicable as of the project approval date.
- Install light colored “cool” roofs and cool pavements.
- Install efficient lighting in all buildings (including residential). Also install lighting control systems, where practical. Use daylight as an integral part of lighting systems in all buildings.
- Install light emitting diodes (LEDs) or other high efficiency lighting for traffic, street and other outdoor lighting.
- Limit the hours of operation or provide minimally acceptable light intensities for outdoor lighting.

Water Conservation & Efficiency

- Design buildings and lots to be water-efficient. Only install water-efficient fixtures and appliances.
- Restrict watering methods (e.g., prohibit systems that apply water to non-vegetated surfaces) and control runoff. Prohibit businesses from using pressure washers for cleaning driveways, parking lots, sidewalks, and street surfaces unless required to mitigate health and safety concerns. These restrictions shall be included in the Covenants, Conditions, and Restrictions of the community.

Solid Waste Measures

- Reuse and recycle construction and demolition waste (including, but not limited to, soil, vegetation, concrete, lumber, metal, and cardboard).

- Provide interior and exterior storage areas for recyclables and green waste at all buildings.
- Provide adequate recycling containers in public areas, including parks, school grounds, paseos, and pedestrian zones in areas of mixed-use development.

Transportation and Motor Vehicles

- Promote ride sharing programs at employment centers (e.g., by designating a certain percentage of parking spaces for ride sharing vehicles, designating adequate passenger loading and unloading zones and waiting areas for ride share vehicles, and providing a web site or message board for coordinating ride sharing).
- At commercial land uses, all forklifts, “yard trucks,” or vehicles that are predominately used on-site at non-residential land uses shall be electric-powered or powered by biofuels (such as biodiesel [B100]) that are produced from waste products, or shall use other technologies that do not rely on direct fossil fuel consumption.
- At commercial land uses, limit idling time for commercial vehicles, including delivery and construction vehicles.
- Promote the use of alternative fuel vehicles and neighborhood electric vehicle programs through prioritized parking within new commercial and retail areas for electric vehicles, hybrid vehicles, and alternative fuel vehicles.
- Provide shuttle service from mixed-use and employment areas to public transit.
- Provide information on all options for individuals and businesses to reduce transportation related emissions, including education and information about public transportation.
- Provide bicycle parking near building entrances to promote cyclist safety, security and convenience.
- Provide secure bicycle storage at public garage parking facilities. Locate facilities and infrastructure in all land use types to encourage the use of low or zero emission vehicles (e.g. electric vehicle charging facilities and conveniently located alternative fueling stations).

STORMWATER RUNOFF MANAGEMENT PLAN

Exhibit D.1 Stormwater Runoff Management Plan

S.R.M.P
(Stormwater Runoff Management Plan)

For

NAPA PIPE REDEVELOPMENT

(Napa Pipe Development Plan)

Prepared By:

CONSULTING CIVIL ENGINEERS
RIECHERS & SPENCE ASSOCIATES

1515 Fourth Street
Napa, California 94559

v 707. 252.3301
f 707. 252.4966

November 8, 2013 Job No. 4106029.0

SRMP

SRMP
Table of Contents

SECTION 1

PROJECT DESCRIPTION

PROJECT DESCRIPTION
NAPA PIPE REDEVELOPMENT

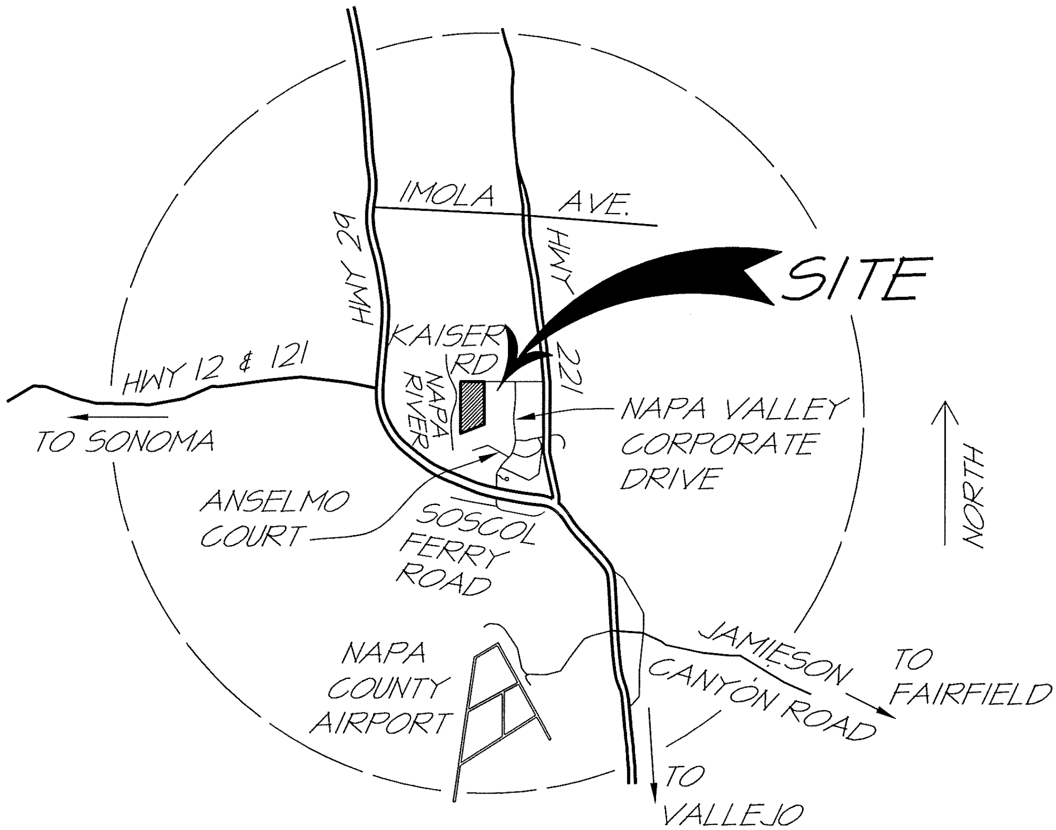
The Napa Pipe Redevelopment project is located at 1025 Kaiser Road in unincorporated Napa County. The project is bound by Kaiser Road to the north, Basalt Road to the east, the Napa River to the west and Bedford Slough/wetlands to the south. This site is also bisected by the Southern Pacific Railroad.

The site was a former industrial pipe fabrication facility and is approximately 154 acres in size. The proposed mix-use redevelopment includes approximately 945 residential units, retail, restaurant, resort, office and other commercial uses, as well as several parks and open spaces. The existing facility is approximately 70% asphalt with very limited perviousness. Several years ago this once non-stormwater treating site installed Vortechnic stormwater separators to mechanically treat some of the water leaving the site.

The current demand in stormwater treatment is via natural systems. When laying out the systems for this project careful consideration was taken to use natural filtration treatment options (bioretention, vegetated swales, etc) and to eliminate any types of mechanical treatment. This project is proposing to treat all the stormwater leaving the site.

SECTION II

VICINITY MAP



VICINITY MAP

NOT TO SCALE

NAPA PIPE REDEVELOPMENT

SECTION III

APPLICABILITY CHECKLIST

(Appendix A)

Post-Construction Runoff Management Applicability Checklist	City of Napa Community Development Department P. O. Box 660 Napa, CA 94559 (707) 257-9530 for information

Project Address:	Assessor Parcel Number(s):	Project Number: *(for City use Only)*
1025 KAISER RD. NAPA	046·412·005, 046·400·030	

Instructions:

Any projects requiring a use permit, building permit, and/or grading permits must complete the following checklist to determine if the project is subject to the Post-Construction Runoff Management Requirements. This form must be completed and submitted with your permit application(s). Definitions are provided in the Post-Construction Runoff Management Requirements policy. **Note:** If multiple building or grading permits are required for a common plan of development, the total project shall be considered for the purpose of filling out this checklist.

POST-CONSTRUCTION STORMWATER BMP REQUIREMENTS (Parts A and B)

✓ If any answer to Part A is answered "yes", your project is subject to the "Priority Project Post-Construction Stormwater BMP Requirements" and "Standard Post-Construction Stormwater BMP Requirements" described in City of Napa's policy for Post-Construction Runoff Management.

✓ If all answers to Part A are "No" and any answers to Part B are "Yes", your project is only subject to the "Standard Post-Construction Stormwater BMP Requirements" described in City of Napa's policy for Post-Construction Runoff Management.

✓ If every question to Part A and B are answered "No", your project is exempt from post-construction runoff management requirements.

Part A: Determine Priority Project Post-Construction Stormwater Requirements

Does the project meet the definition of one or more of the priority project categories?

1. Residential subdivisions with 10 or more units .... (Yes) No
2. Commercial development greater than 100,000 square feet new impervious area .... (Yes) No
3. Automotive repair shop .... Yes (No)
4. Retail Gasoline outlet .... (Yes) No
5. Restaurant .... (Yes) No
6. Hillside residential development contemplates grading on any natural slope that is twenty-five percent or greater. Yes (No)
7. Parking lots with greater than 25 spaces or greater than 5,000 square feet of impervious area and exposed to storm water runoff (Yes) No

* Refer to the definitions section in the Stormwater Standards Development Manual for expanded definitions of the priority project categories.

Part B: Determine Standard Post-Construction Stormwater Requirements

Does the project propose:

1. Require a General NPDES Permit for Stormwater Discharges Associated with **Industrial** Activities? .... Yes (No)
2. Impervious surfaces 10,000 or more sq. ft.? .... (Yes) No
3. Impervious surfaces within 100 feet of Receiving Waters? .... (Yes) No
4. Vehicle or equipment fueling, washing, or maintenance areas? .... (Yes) No
5. Commercial or industrial waste handling or storage, excluding typical office or household waste? .... (Yes) No
6. New projects disturbing greater than or equal to one acre .... (Yes) No

Note: To find out if your project is required to obtain an individual General NPDES Permit for Stormwater discharges Associated with Industrial Activities, visit the State Water Resources Control Board website at, www.swrcb.ca.gov/stormwtr/industrial.html

APPENDIX A – Applicability Checklist

SECTION IV

APPLICATION FOR SRMP REVIEW

(Appendix B)

TO BE COMPLETED BY APPLICANT

(Please type or print legibly)

Site Address/Location: 1025 (No) KAISER RD (Street) NAPA (City)

Assessor's Parcel #: 046-412-005, 046-400-030

City Project Number # ______ *(to be completed by City staff)*

Applicant's Name: NAPA REDEVELOPMENT PARTNERS **Company:** ROGAL WALSH MOL

Telephone #: (707) 251-0123 **Fax #:** ( ) **E-Mail:** KEITH@ROGALWALSHMOL.COM

Mailing Address: 1025 (No) KAISER RD (Street) NAPA (City) CA (State) 94559 (Zip)

Status of Applicant's Interest in Property: OWNER/DEVELOPER

Property Owner's Name: NAPA REDEVELOPMENT PARTNERS

Telephone #: (707) 251-0123 **Fax #:** ( ) **E-Mail:** KEITH@ROGALWALSHMOL.COM

Mailing Address: 1025 (No) KAISER RD (Street) NAPA (City) CA (State) 94559 (Zip)

Project Category (see definitions in the Post-Construction Runoff Management Requirements policy)

☒ **Priority Project** _X_ Residential with 10 or more units _X_ 100,000 sq ft Commercial ___ Auto Service Facility
_X_ Restaurant ___ Hillside Residence _X_ Parking Lot _X_ Retail Gasoline Outlet

☒ **Standard Project** ___ Industrial NPDES _X_ New Impervious Surface _X_ Earthmoving > 50 cu yds
_X_ Within 100 ft of Receiving Waters _X_ New or alteration of storm drains ___ Liquid or solid material
_X_ Vehicle/Equipment maintenance or cleaning ___ Commercial/Industrial waste handling or storage
_X_ Project Site greater than or equal to one acre (43,560 square feet)

Parcel Size: 152 acres **Disturbed Area:** ~~152~~ 140 ☒ acres ☐ ft^2. **Amount of Cut & Fill:** 1.5 million yds^3

Existing Impervious Area: 107 acres ~~ft^2~~ **Additional Impervious Area:** N/A ☒ ft^2 (less impervious in developed condition.)

Percent Slope: Minimum: 0.5% Maximum: 2:1 Average: 1%-2%

Min distance between project footprint and receiving waters: 10 feet

Construction of New Public Storm Drains: ☒ Yes ☐ No **Construction of Stream Crossing:** ☒ Yes ☐ No

Construction of New Outfall: ☒ Yes ☐ No

Related Permits (Filed/Issued/NA): _X_ NPDES _X_ DFG 1600 _X_ RWQCB 401 _X_ ACE 404

SIGNATURE: I hereby certify that all the information contained in this application, including but not limited to, this application form, the supplemental information sheets, site plan, plot plan, cross sections/elevations, is complete and accurate to the best of my knowledge. I hereby authorize such investigations including access to County Assessor's Records as are deemed necessary by the Department of Public Works for evaluation of this application and preparation of reports related thereto, including the right of access to the property involved.

[signature] 11/22/13

Signature of Applicant *Date* *Signature of Property Owner* *Date*

(FOR KEITH ROGAL)

APPENDIX B – Application for SRMP Review

SECTION V

SRMP CHECKLIST FOR A COMPLETE APPLICATION

(Appendix C)

FOR OFFICIAL USE ONLY	
PLAN REVIEWER: ______	DATE RECEIVED: ______
PROJECT NAME: ______	PROJECT NUMBER: ______
PERMIT CATEGORY: ☐ Use Permit ☐ Building Permit ☐ Grading Permit ☐ Subdivision or Parcel Map	

Project Category (check all applicable Priority or Standard Project categories)	
☒ **Priority Project**	☐ **Standard Project**
_X_ Residential Subdivision with 10 or more units	____ Industrial NPDES permit
_X_ 100,000 sq ft commercial	____ Site area equal to or greater than one acre (43,560 s.f.)
____ Automotive repair shop	____ Disturbance within 150 feet of receiving waters
_X_ Restaurant	____ New or alteration of storm drains
____ Hillside Residence	____ Liquid or solid material loading areas
_X_ Parking Lot	____ Vehicle or equipment maintenance
_X_ Retail Gasoline Outlet	____ Commercial or industrial waste handling and storage
	____ Earthmoving > 50 cu yds

At a minimum, the Stormwater Runoff Management Plan must cover the areas listed below.

√ = Complete, X = Incomplete, NA = Not Applicable

A. Planning and Organization

1. _X_ Completed SRMP General Information Form.
2. _X_ Vicinity map showing the site in relation to the surrounding area. - SEE ATTACHED
3. _X_ If applicable, incorporate or reference other regulatory permits and their requirements. **Note:** All State and Federal Permits (1600, 401/404, General Permit, etc) must be approved prior to any construction within State Waters.
4. _X_ Describe the nature of the proposed use of the development project. - PROJECT DESCRIPTION (SEE ATTACHED)

B. Identify Pollutants and Conditions of Concern

1. _X_ Standard and Priority Projects proposing 10,000 or more sq. ft. of new impervious surface must prepare a drainage study that calculates the pre-development peak runoff rate according to the criteria in Section III.1.A. (PRELIMINARY CALCS FOR HYDROLOGY)
2. _X_ Standard and Priority Projects must provide a list and description of all anticipated activities associated with the use of the proposed project. The description of each activity must include a list of pollutants potentially generated from the activity.
3. _X_ Standard and Priority Projects must list and describe all stormwater conveyance systems (e.g. storm drain, ditch, creek, etc) within 100 feet minimum of the project footprint. Discretionary projects must also provide an analysis for all open stormwater conveyance systems. At a minimum, the analysis must consider bank stability, vegetative cover, and the presence of non-native invasive species.
4. _X_ Priority Projects proposing 10,000 or more sq. ft. of new impervious surface must list all applicable Project Pollution Sources and Pollutants of Concern from Table 2 in Section III.1.A.
   Limited Exclusion: Single Family Hillside Residences

APPENDIX C – SRMP Checklist for a Complete Application

Page 1 of 3

5. X Priority Projects proposing 10,000 or more sq. ft. of new impervious surface must list all receiving waters in Table 3 potentially impacted by the project and the pollutants contributing to their impairment.
Limited Exclusion: Single Family Hillside Residences

D. Post-Construction BMPs

Site Design BMPs

1. X List and describe all Site Design BMPs used to moderate stormwater runoff rates.
Limited Exclusion: Projects proposing less than 10,000 sq. ft. new impervious surfaces

2. X List and describe all structures (outfalls, culverts, etc.) proposed within the jurisdiction of the DFG, RWQCB, and/or ACOE. The description must include the structure's specifications and designed storm capacity. The structure must be constructed in accordance with all applicable State and Federal permits.

3. X Provide the average slope and minimum and maximum distance between the project footprint and all open stormwater conveyance systems (e.g. ditches, creeks, etc.). Ministerial projects must establish setbacks from blue-line streams that comply with the stream setback requirements in the Conservation Regulations. Discretionary projects may establish and/or restore wider buffers zones to protect aquatic resources and structures.

Source Control BMPs

4. X List and describe all source control measures included in the project design to eliminate pollutant contact with stormwater from the anticipated activities identified above. The description must include the location and design specifications for each source control BMP.

Individual Priority Project Category BMPs

5. X Priority Projects must list and describe all applicable post-construction BMPs incorporated into the project design that satisfy the standards in Section III.2.C. The description must include the location and design specifications for each post-construction BMP.

Treatment Control BMPs

6. X Priority Projects with 10,000 or more sq. ft of new impervious surfaces must list and describe all treatment control BMPs selected according to the procedures in Section III.2.D. The description must include the location and design specifications for each treatment control BMP.

7. X Provide the calculations used to design the treatment control BMPs to satisfy the numeric sizing treatment standards in Table 4, Section III.2.D. Applicants may count the site design BMPs toward meeting these numeric standards. (PRELIMINARY BMP CALCULATIONS – SEE ATTACHED)

F. Site Plan

The site plan shall be neat and legible and shall be drawn on a 24" X 36" sheet and shall be folded to 8 ½ " by 11" prior to submittal. When two or more sheets are used to illustrate the plan view, an index sheet is required, illustrating the entire project on one (1) 24" x 36" (minimum) sheet. The entire parcel shall be identified on the plan. If only a portion of the site will be developed, the entire parcel may be shown as a detail, with the area to be developed, cleared, and/or graded drawn to an appropriate scale.

The site plan shall include all of the following:

1. X Provide and legend and north arrow on the plan.
2. X Maximum plan scale of 1" = 100'.

APPENDIX C – SRMP Checklist for a Complete Application

Page 2 of 3

3. X An outline of the entire property.
4. X Provide a "limit of disturbance" line which shows the limit of soil disturbance and areas where existing vegetation is preserved.
5. X All open stormwater conveyance systems (e.g. ditches, creeks) and setback distances must be delineated.
6. X State and Federal wetlands must be accurately delineated.
7. X The National Flood Insurance Program 100 Year Flood Zone and Flood Way must be delineated.
8. X Drainage areas on the property and direction of flow. Map must extend as far outside the site perimeter as necessary to illustrate relevant drainage areas. Where relevant drainage areas are too large to depict on the map, map notes or inserts are sufficient.
9. X All storm drain inlets and outlets must be located on the plan.
10. X Anticipated stormwater discharge locations.
11. X Location of existing and future post-construction stormwater controls (e.g. oil/ water separators, sumps, grassy swales, buffers, etc.).
12. X Location of existing and future "impervious" areas - paved areas, buildings, covered areas.

G. Post-Construction BMP Implementation and Maintenance Agreement

1. X See Appendix G-Post-Construction BMP Maintenance Mechanism for the appropriate mechanism for this project.
2. X Include a signed Owner's Certification that states "I, the undersigned, certify that all land clearing, construction and development shall be done pursuant to the approved plan." This must be signed in ink on each plan submitted or on an original reproducible.

APPENDIX C – SRMP Checklist for a Complete Application

Napa Pipe Redevelopment

APN's 046-412-005 & 046-400-030

SRMP – Appendix C

A1 – Appendix A – See attached.

A2 – Vicinity Map – See attached.

A3 – A CDFW 1600 permit, SWRQCB 401 permit and ACOE 404 permit will be required for the project. These are being processed separately and are currently underway.

A4 – The Napa Pipe property is located in south Napa County adjacent to existing rail lines and the Napa River. The 154-acre property is almost entirely paved over, and has been fenced off and occupied by large-scale industrial buildings located throughout. The project development includes the construction of roads, dwelling units, retail/restaurant spaces, light industrial and office spaces.

B2 – Appendix E/F – See attached.

B3 – The project is proposing storm drainage improvements necessary for draining the entire proposed development. New swales will be lined with vegetation or rock. New storm drain swales and pipe systems will flow to existing outlets at the Napa River.

B4 – Appendix E/F – See attached.

B5 – Appendix E/F – See Attached

D1 – Bioretention pop-outs, flow-through planters and grassy Swales are proposed to be installed.. All storm drainage from proposed improvements flows out to Napa River using the outlets that are existing. One new outfall will be constructed in one of the dry docks.

D2 – The project storm drainage system flows out to Napa River using the outlets that are existing. One new outfall will be constructed in one of the dry docks. This is not under the jurisdiction of ACOE or CDFW.

D3 – The project site will be generally flat. The Napa River is located just west of the subject property. Slopes vary from about 0.5% to 2:1 slopes. The majority of the site will be in the 1%-2% range.

D4 – Appendix E – See attached.

D5 – Appendix F – See attached.

SECTION VI

POLLUTANT IDENTIFICATION

(Appendix E & Appendix F)

NAPA COUNTY POST-CONSTRUCTION RUNOFF MANAGEMENT REQUIREMENTS
APPENDIX E – SOURCE CONTROL BMP SELECTION WORKSHEET

All Standard and Priority Projects must complete and sign the Source Control BMP Selection Worksheet and submit it with their Stormwater Runoff Management Plan (SRMP).

Date of Application: 11/22/13

Project Number:
(For County Use Only)

Type of Application: ☒ Use Permit ☐ Building Permit ☐ Grading Permit

Project Location or Address: 1025 KAISER RD, NAPA

Project Name: NAPA PIPE REDEVELOPMENT

Property Owner Name: NAPA REDEVELOPMENT PARTNERS

Applicant's Name: KEITH ROGAL

☒ Owner ☐ Contractor ☐ Engineer/Architect ☒ Developer

Applicant's Address: 1025 KAISER RD, NAPA

Applicant's Phone: 707-251-0123 **Fax:** ______ **E-mail:** KEITH@ROGALWALSHMOL.COM

Parcel/Tract #: ______ **Lot #:** ______ **APN:** 046-412-005, 046-400-030

Fill out the table below to indicate which Source Control BMPs in Chapter 4.2 apply to your project.

Check box to indicate proposed activity	Land Use/Activities	Limited Exclusion (Check box if project is excluded)	Source Control BMP Standard
X	Roads and driveways.	None	4.2.A
X	Parking Areas	None	4.2.B
X	New or Reconstructed Stormwater Conveyance Systems	None	4.2.C
X	Storm drain Inlets and open channels or creeks.	☐ Detached Residential Homes	4.2.D
X	Landscaping	None	4.2.E
X	Trash Storage Areas.	☐ Detached Residential Homes	4.2.F
	Pools, Spas, and Fountains.	None	4.2.G
X	Roofs, Gutters, and Downspouts.	None	4.2.H
	Loading and Unloading Dock Areas	None	4.2.I
X	Outdoor Material Storage Areas.	☐ Detached Residential Homes	4.2.J
	Processing Areas.	None	4.2.K
X	Vehicle and Equipment Repair and Maintenance Areas	☐ Detached Residential Homes	4.2.L
X	Vehicle and Equipment Wash Areas	☐ Detached Residential Homes	4.2.M
	Food Service Equipment Cleaning	None	4.2.N
	Interior Floor Drains.	None	4.2.O
	Fueling Areas.	None	4.2.P

Incorrect information on proposed activities or uses of a project may delay your project application(s) or permit(s).

I declare under penalty of perjury, that to the best of my knowledge, the information presented herein is accurate and complete.

Name of Owner or Agent (Please Print):	Title:
JEREMY SILL	ENGINEER
Signature of Owner or Agent: [signature]	Date: 11/22/13

Draft Date: June 3, 2008 Page 1 of 1

NAPA COUNTY POST-CONSTRUCTION RUNOFF MANAGEMENT REQUIREMENTS
APPENDIX F - TREATMENT CONTROL BMP SELECTION WORKSHEET

This worksheet was developed to help you with the selection of a Treatment Control BMP or combination of Treatment Control BMPs to remove anticipated pollutants, to the maximum extent practicable, from stormwater runoff generated during the use of the project. All project applications subject to Treatment Control BMP requirements must submit this worksheet with their SRMP.

Date of Application: 11/22/13

Project Number:
(For county Use Only)

Type of Application: ☑ Use Permit ☐ Building Permit ☐ Grading Permit

Project Location or Address: 1025 KAISER RD., NAPA

Project Name: NAPA PIPE REDEVELOPMENT

Property Owner Name: NAPA REDEVELOPMENT PARTNERS

Applicant's Name: KEITH ROGAL

☑ Owner ☐ Contractor ☐ Engineer/Architect ☑ Developer

Applicant's Address: 1025 KAISER RD, NAPA

Applicant's Phone: 707·251·0123 **Fax:** ______ **E-mail:** KEITHC ROGALWALSAMOL.COM

Parcel/Tract #: ______ **Lot #:** ______ **APN:** 046·412·005, 046·400·030

Step 1: Determine Anticipated Pollutants of Concern
Use the table below to determine the types of anticipated pollutants your project may generate based on land use type.

Check Box to Indicate Proposed Land Use	Project Pollutant Sources	Pollutants of Concern	If you checked a box next to a land use that may potentially generate a pollutant or stressor, explain why that pollutant or stressor is or is not anticipated to be generated by the proposed project.
X	Lawns, Landscaping, and Parks	Sediment (coarse and fine) Nutrients (dissolved and particulate) Pesticides, pathogens, trash and debris	AREAS WILL BE VEGETATED AND METICULOUSLY MAINTAINED – VERY LITTLE POLLUTANTS
X	Parking Lots and Driveways	Sediment (fine) Metals (dissolved and particulate) TPH, trash	SOME SEDIMENT & METALS ANTICIPATED BUT WILL BE MITIGATED THROUGH BMP'S.
X	Roads and Highways	Sediment (coarse and fine) Metals (dissolved and particulate) TPH, PAH, trash and debris	SAME AS ABOVE
X	Food-Related Commercial	Pathogens, oil and grease	GREASE INTERCEPTORS WILL BE USED TO CONTROL FOOD-RELATED POLLUTANTS.
	Animal-Related Commercial	Pathogens	
	Auto-Related Commercial	Metals (dissolved and particulate) TPH, PAH, surfactants	
	Industrial	Sediment (coarse and fine) Metals (dissolved and particulate) TPH, PAH, PCB, pH, surfactants	

Step 2: Determine Conditions of Concern for Receiving Waters
Check off the watershed your project is located in to determine the conditions of concern downstream from your project. This information will help you select treatment control BMP(s) that maximize the removal of pollutants that are already impairing downstream receiving waters.

Draft Date: June 3, 2008 Page 1 of 3

NAPA COUNTY POST-CONSTRUCTION RUNOFF MANAGEMENT REQUIREMENTS
APPENDIX F - TREATMENT CONTROL BMP SELECTION WORKSHEET

☒ **Napa River and tributaries**
- Sediment
- Nutrients
- Pathogens
- Mercury
- Nickel
- Selenium
- Furan Compounds
- Chlordane
- Diazinon
- PCBs

☐ **Putah Creek and tributaries**
- Mercury
- Nickel
- Selenium
- Furan Compounds
- Chlordane
- Diazinon
- PCBs

☐ **Susuin Creek and tributaries**
- Mercury
- Nickel
- Selenium
- Furan Compounds
- Chlordane
- Diazinon
- PCBs

Step 3: Select Treatment Control BMPs
Based upon your list of anticipated pollutants of concern (Step 1) and the conditions of concern downstream of your project (Step 2) you are ready to select the treatment control BMPs that maximize the removal of these pollutants. Using the table below, break your project into discrete drainage areas and list the land uses and associated pollutants of concern within each drainage area. Then refer to the Treatment Control BMP Selection Matrix to select BMPs for each drainage area that maximize the removal of anticipated pollutants.

Note: If the project is anticipated to generate one or more pollutants (Step 1) that the receiving water is listed for, select one or more BMPs from Treatment Control BMP Selection Matrix (Table 5) that maximize the removal for those pollutants. Any pollutants the project is expected to generate that are also causing a Clean Water Act section 303(d) impairment of the downstream receiving shall be given top priority in selecting treatment BMPs.

Basin	Anticipated Activities	Anticipated Pollutants	Treatment BMP	Treatment BMP Performance
NAPA RIVER	PARKING LOTS	SEDIMENT/METALS	DET BASIN/BIOFILTER	6
	ROADWAYS	SEDIMENT/METALS	DET BASIN/BIOFILTER	6
	PARKS	SEDIMENT/TRASH	DET. BASINS/BIOFILTER	6/F
	FOOD-RELATED	OIL/GREASE	SOLID SEPARATOR	6

Note that site conditions (soil type, groundwater elevation), size of the project, and other factors may limit your options for treatment control BMPs. If you cannot design a treatment control BMP or combination of treatment control BMPs into your project design, use the table below to list better performing treatment control BMPs and explain why they cannot be incorporated into the project design.

Basin	Treatment Control BMP	Statement of Impracticability

Draft Date: June 3, 2008

Page 2 of 3

NAPA COUNTY POST-CONSTRUCTION RUNOFF MANAGEMENT REQUIREMENTS
APPENDIX F - TREATMENT CONTROL BMP SELECTION WORKSHEET

Treatment Control BMP Selection Matrix.

Note: The Treatment control BMP Selection Matrix is provided for guidance purposes only. The performance of any given BMP may depend on the pollutant loading generated as well as local site conditions such as soil type and topography. The selection process must take into account the suitability of the BMP for the site. Alternative treatment control BMPs not identified in the matrix below may be approved at the discretion of the Director, provided the alternative BMP is as effective, or more effective, in the removal of pollutants of concern as other feasible BMPs listed in the matrix.

BMP Type	BMP	Constituent/Performance (G = Good, F = Fair, P = Poor)										
		Coarse Sed	Fine Sed	NO_3	Total N	Total P	Pb	Zn	Cu	Pathogens	Oil and Grease	Trash and Debris
Detention Basins	Wet Pond	G	G	P	F	F	G	G	F	F	NR	G
	Extended Wet Pond	G	G	F	F	G	G	G	P	F	NR	G
	Extended Dry Pond	G	F	P	F	P	F	F	F	P	NR	G
Water Quality Wetlands	Shallow Wetlands	G	G	F	P	F	F	G	F	G	NR	G
	Extended Detention Wetland	G	G	F	P	F	F	G	F	G	NR	G
Biofilters (Horizontal)	Bioswale	G	F	P	F	F	G	F	F	P	F	F
	Filter Strip	G	F	P	F	F	G	F	F	P	F	F
Filters (Vertical)	Sand Filter	G	G	P	F	F	G	G	F	F	G	G
	Media Filter	G	G	P	F	F	G	G	G	F	F	NR
	Bioretention	G	G	P	G	G	G	G	G	P	G	NR
Solid Separators	Rotational Flow	G	F	P	F	F	F	F	F	P	G*	G
	Multi-Chamber	F	P	P	F	P	F	F	P	P	F	G
Inserts	Catch Basin Insert	G	F	P	F	F	F	F	F	P	G*	G

Incorrect information on proposed activities or uses of a project may delay your project application(s) or permit(s).

I declare under penalty of perjury, that to the best of my knowledge, the information presented herein is accurate and complete.

Name of Owner or Agent (Please Print):	Title:
JEREMY SILL	ENGINEER
Signature of Owner or Agent:	Date:
	11/22/13

Draft Date: June 3, 2008

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NAPA COUNTY POST-CONSTRUCTION RUNOFF MANAGEMENT REQUIREMENTS
APPENDIX G – VECTOR MANGEMENT CONSIDERATIONS FOR STORMWATER BMPs

BACKGROUND

The Napa County Mosquito Abatement District (NCMAD) has the responsibility for providing enforcement of mosquito control measures when public health is threatened. It is concerned with the spread of insects and other nuisance pests that could result from poorly designed and/or maintained structures, especially those containing standing water. Detention basins, water quality wetlands and infiltration basins are examples of stormwater treatment control structures that may offer prime breeding habitats for mosquitoes and other nuisance pests if not properly designed and maintained. Stagnant water associated with stormwater treatment can provide habitat for the aquatic stages of mosquitoes. NCMAD and other California vector control districts are particularly concerned that the expanding number of treatment controls may result in increased mosquito habitat at the same time as the potential arrival of West Nile Virus. Napa County is working with the NCMAD to develop favorable treatment control design standards.

USING SITE DESIGN TO MINIMIZE MOSQUITO VECTOR CONTROL CONCERNS

Proper site design offers an excellent opportunity to minimize stormwater impacts and mosquito threats by minimizing the treatment controls needed, and by properly designing and placing those that are needed to reduce potential vector impacts. Based on available literature and current BMP implementation strategies nationwide, the following general principles for proper site designs should be considered.

• **Preserve natural drainage**. This reduces the amount of stormwater runoff and provides for natural on-site runoff control. This can reduce the number of structural BMP measures required.

• **Improve designs of permanent pools**. Reduce mosquito habitat: increase circulation and provide deeper water depths. Stock permanently flooded systems with mosquito fish to foster biological predation on mosquito larvae.

• **Select stormwater management measures based on site-specific conditions**. Designs that take into account site conditions tend to improve drainage and limit the occurrence of stagnant water.

• **Attend to ponds that temporarily impound water**. Facilities that pond water for an extended period (e.g., dry ponds, and man-made wetlands) should drain water completely within seventy-two (72) hours of a storm event. Avoid placement of dry ponds and underground structures in areas where they are likely to remain wet (i.e., high water tables). Principal outlets should have positive drainage.[1]

• **Properly design storm sewer systems**. The sheltered environment in-side storm drains can promote mosquito breeding. Design and construct pipes for a rate of flow that flushes the system of sediment and prevents water backing up in the pipe. Construct storm drains so that the invert out is at the same elevation as the interior bottom to prevent standing water.

• **Properly maintain controls.** Any circumstances that restrict the flow of water from a system as designed should be corrected. Debris or silt buildup obstructing an outfall structure should be removed. Under-drains and filtration media should be inspected periodically and cleaned out or replaced as needed.

ADDRESSING VECTOR CONTROL CONSIDERATIONS IN STORMWATER TREATMENT BMPS.

While addressing stormwater quality via proper site design planning is the best method for minimizing long-term maintenance requirements and vector concerns, some projects still require stormwater treatment systems due to the size of the project. In such cases, project proponents should consider the

[1] In Napa County, there is no mosquito that will complete development in less than seven days, even during the warmest conditions. Once the mosquito reaches the pupal stage, it can complete development without water as long as the soil remains damp. Therefore, a realistic limit on the duration of standing water is five days, even allowing for a considerable margin of error.

following standards when selecting and designing these systems for their site. Municipalities should review proposed stormwater treatment BMPs designs with vector control in mind.

Proper BMP Designs to Reduce or Eliminate Mosquito Production. NCMAD has identified several stormwater BMP maintenance objectives to reduce or eliminate mosquito production. These include the following:

• Minimize stagnant water (i.e., maintain constant exchange of water in systems);

• Minimize surface area (i.e., deeper water habitat is preferable);

• Keep wetland edges simple (e.g., steep banks with deep water);

• Prevent mosquito access to underground systems that may have standing water. Use siphons and sealed access to prevent mosquito access.

• Include mosquito net covering sand media filter pump sumps;

• Include aluminum "smoke proof" cover for any vault sedimentation basins;

• Use grouted rock energy dissipaters instead of loose rock; and

• Construct sites so that there is access to the water's surface. Any underground site that might create mosquito habitat in stagnant water should have easy access for direct inspection and insecticidal treatment.

Vector-control personnel throughout the United States have found that aquatic habitats that last only three (3) to five (5) days generally do not allow for complete development of mosquito larvae[2]. In addition, cold temperatures that often occur during the rainy season suppress mosquito production. In Napa County, with the exception of certain BMPs designed to hold permanent water (e.g. detention or wet ponds), all BMPs should drain completely within seventy-two (72) hours to effectively suppress vector production. Access for routine maintenance and vector control is also imperative in BMP design.

Improper BMP Design and Maintenance Can Lead to Additional Mosquito Production. Improper BMP selection, design, and maintenance contribute to mosquito production. Stormwater BMPs (and their associated structures and/or components) that may create a suitable habitat for mosquito production include:[3]

• Any BMP that clogs, improperly drains and/or collects debris;

• Catch basins and settling basins that are exposed;

• Effluent pipes with small diameter discharge orifices prone to clogging;

• Loose riprap;

• Pumps or motors designed to automatically drain water from structures;

• Retention ponds, continuous deflective separation (CDS) units, Delaware sand filters, multi-chambered treatment trains (MCTT), wet basins and other BMPs that maintain a pool of standing water;

• Sumps, catch basins and settling basins that are covered or located below ground;

• Sumps, catch basins, spreader troughs or other BMPs that do not drain completely; and,

• Underground detention systems, sumps or other BMPs that are unsealed or have openings.

---

[2] Metzger et al., 2003
[3] This list may not be totally inclusive of all stormwater BMPs that provide potential habitats for mosquitoes.

NAPA COUNTY POST-CONSTRUCTION RUNOFF MANAGEMENT REQUIREMENTS
APPENDIX G – VECTOR MANGEMENT CONSIDERATIONS FOR STORMWATER BMPs

ADDITIONAL RESOURCES FOR GUIDANCE ON VECTOR CONTROLS

Additionally, the following materials regarding mosquitoes and factors contributing to mosquito production within BMPs may be obtained from the Napa County Stormwater Management Program website (www.napastormwater.org):

• *The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs;*

• *Stormwater Treatment Devices as Potential Breeding Grounds for Disease Carriers;*

• *Disease Vectors Associated with Stormwater Treatment Devices in California;*

• *The Downside of Stormwater Runoff Management: Disease Vectors & Structural BMPs in Southern California.*

SECTION VII

BMP SELECTIONS

(Site Design BMP's, Source Control BMP's & Treatment Control BMP's)

NAPA PIPE REDEVLOPMENT
POST-CONSTRUCTION BMP'S

- **SITE DESIGN BMP'S**
  - Homeowner education on stormwater pollution prevention
  - Splash blocks to yard swales
  - Pervious paving
- **SOURCE CONTROL BMP'S**
  - Material and waster storage areas
  - Concrete wash-out areas
  - Vehicle & equipment storage and service areas
  - Concrete stamping of all inlets with "No Dumping – Drains to Napa River"
- **TREATMENT CONTROL BMP'S**
  - Bioretention Areas
  - Vegetated Swales

SECTION VIII

PRELIMINARY BMP CALCULATIONS

(Bioretention Area & Vegetated Swales)

PRELIMINARY CALCULATIONS FOR BMP's (Best Management Practices)

NAPA PIPE REDEVELOPMENT PROJECT

(Napa Pipe Development Plan)

Prepared By:

CONSULTING CIVIL ENGINEERS
RIECHERS & SPENCE ASSOCIATES

1515 Fourth Street
Napa, California 94559

v 707. 252.3301
f 707. 252.4966

November 8, 2013 Job No. 4106029.0

PRELIMINARY BMP CALCULATIONS

Table of Contents

Appendix C: Cisterns / Rain Barrels

- Reference Exhibit - Contra Costa County Stormwater C.3 Guidebook, 2006 (or approved equal), Downspout and Cistern Fact Sheets

Appendix D: Green Roofs

- Reference Exhibit - Contra Costa County Stormwater C.3 Guidebook, 2006 (or approved equal), Green Roof Fact Sheet

Appendix E: Pervious Pavement

- Reference Exhibit - California Stormwater Quality Association (CASQA), SD-20, Pervious Pavement Fact Sheets

BMP Report
For the
Napa Pipe Redevelopment Project
(Vesting Tentative Subdivision Map)

Purpose

The purpose of this report is to evaluate the stormwater treatment elements of the Napa Pipe Redevelopment project.

Introduction

The Napa Pipe Redevelopment project is located at 1025 Kaiser Road in unincorporated Napa County. The project is bound by Kaiser Road to the north, Basalt Road to the east, the Napa River to the west and Bedford Slough / wetlands to the south. The site is also bisected by the Southern Pacific Railroad.

The site was a former industrial pipe fabrication facility and is approximately 154 acres in size. The proposed mix-use redevelopment includes approximately 945 residential units as well as retail, restaurant, hotel, office and other commercial uses. Several parks, public facilities and open spaces will be incorporated as well. The existing facility is nearly 70% asphalt with minimal pervious surfaces. A small portion of the existing site drains to mechanical stormwater separators to help treat runoff prior to entering the river.

The current movement in stormwater management is via natural treatment. In design of the systems for this project careful consideration was taken to use natural filtration treatment options (bioretention, grassy swales, etc) and to eliminate any types of mechanical treatment. This project is proposing to treat all the stormwater leaving the site.

BMP Methodology

The sizing methods shown in this report were based off widely accepted methods for designing BMPs. The Napa County Stormwater Standards set requirements for flow and volume treatment and these values were utilized in calculations where appropriate. Additional sources were called upon to reiterate the calculation parameters and methods. These sources are detailed in this BMP report.

Requirements

The Napa County Post-Contruction Runoff Management Standards and the Napa County Road and Street Standards were utilized to size and design the project BMP's. Both flow and volume methods were applied to accurately size retention and flow-through devices.

Requirements and design guidelines from the California Stormater Quality Association (CASQA) handbook was also used to design water quality elements of the project.

Infrastructure

Several types of BMPs are proposed for the Napa Pipe Redevelopment project. A list of BMPs used, but not limited to, are:

- ***Bioretention Areas*** (Appendix A) - Street drainage on surrounding streets in all land-use areas will be treated by Bioretention Areas located at low points of the streets within the parkway and/or within traffic calming bulb-outs. Some areas in the commercial, retail, and light industrial areas may also be treated with Bioretention facilities.

- ***Flow-through Planters*** (Appendix A) - Roof drainage from the townhouse blocks will be primarily treated by Flow-through Planters within the block. Some areas in the commercial, retail, and light industrial areas may also be treated with Flow-through Planters.

- ***Vegetated Swales*** (Appendix B) - Some portions of street drainage will be treated by Vegetated Swales within the railroad park located parallel to the existing railroad tracks. The drainage that falls directly onto the railroad park will also be treated by way of a vegetated swale. Some portions of street drainage may also be treated by Vegetated Swales located parallel to Street A.

- ***Cisterns/Rain Barrels*** (Appendix C) - Roof drainage from the townhouse blocks may use Cisterns/Rain Barrels as an option.

- ***Green Roofs*** (Appendix D) – Several of the residential blocks and parking strutures may be built with Green Roofs. and roof drainage within the blocks will be treated by BMPs. Some buildings in the commercial, retail, and light industrial areas can also be treated with Green Roofs.

- ***Pervious Pavements*** (Appendix E) - Alley drainage will be treated by infiltration through Pervious Pavement.

It is assumed that at-grade landscape areas would be self-treating.

Conclusion

The post-construction BMPs proposed for this project will provide stormwater quality treatment for the design storm (85th percentile event) consistent with Napa County post-construction runoff management standards and current industry best practices.

Appendix A

Bioretention Areas & Flow-through Planters

Reference Exhibits

Napa County Post-construction Runoff Management
Management Requirements (NCPRMR),
Napa County Road & Street Standards (NCRSS)
and
California Stormwater Quality Association (CASQA)

BMP Exhibits & Calculations

Street Area

3 Worst Case Scenarios (The 3 worst case scenarios within the street areas were used to calculate minimum BMP areas)
& Overall Street Area

Sideyard Swale/Bioretention

Flow-through Planter

(With Flow-through Planter Fact Sheets)

The canopy must not drain onto the fuel dispensing area, and the canopy downspouts must be routed to prevent drainage across the fueling area.

2. All fuel dispensing areas must be paved with Portland cement concrete (or equivalent smooth impervious surface), and the use of asphalt concrete shall be prohibited.
3. All fuel dispensing areas must have a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents runon of storm water to the extent practicable.
4. At a minimum, the concrete fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.
5. Above-ground fuel tanks must be protected with a secondary containment structure of sufficient volume to contain all of the fuel in the event of a tank rupture or leak.

4.3 Treatment Control BMPs

A. Treatment BMP Sizing Standards

After site design and source control BMPs have been incorporated into the project design, priority projects subject to the treatment control requirements (see Table 2) shall design a single or combination of treatment control BMPs designed to infiltrate, filter, and/or treat runoff from the project footprint to one of the "Numeric Sizing Treatment Standards" listed below.

<u>VOLUME</u>

Volume-based BMPs shall be designed to mitigate (infiltrate, filter, or treat) either:

a. The 85th percentile 24-hour runoff event determined as the maximized capture storm water volume for the area, from the formula recommended in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998); or
b. The volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment by the method recommended in California Stormwater Best Management Practices Handbook – Industrial/ Commercial, (2003); or
c. The volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for "treatment" that achieves approximately the same reduction in pollutant loads achieved by the 85th percentile 24-hour runoff event.

<u>Flow</u>

Flow-based BMPs shall be designed to mitigate (infiltrate, filter, or treat) either:

a. The flow of runoff produced from a rain event equal to at least two times the 85th percentile hourly rainfall intensity for the area; or
b. The flow of runoff produced from a rain event that will result in treatment of the same portion of runoff as treated using volumetric standards above.

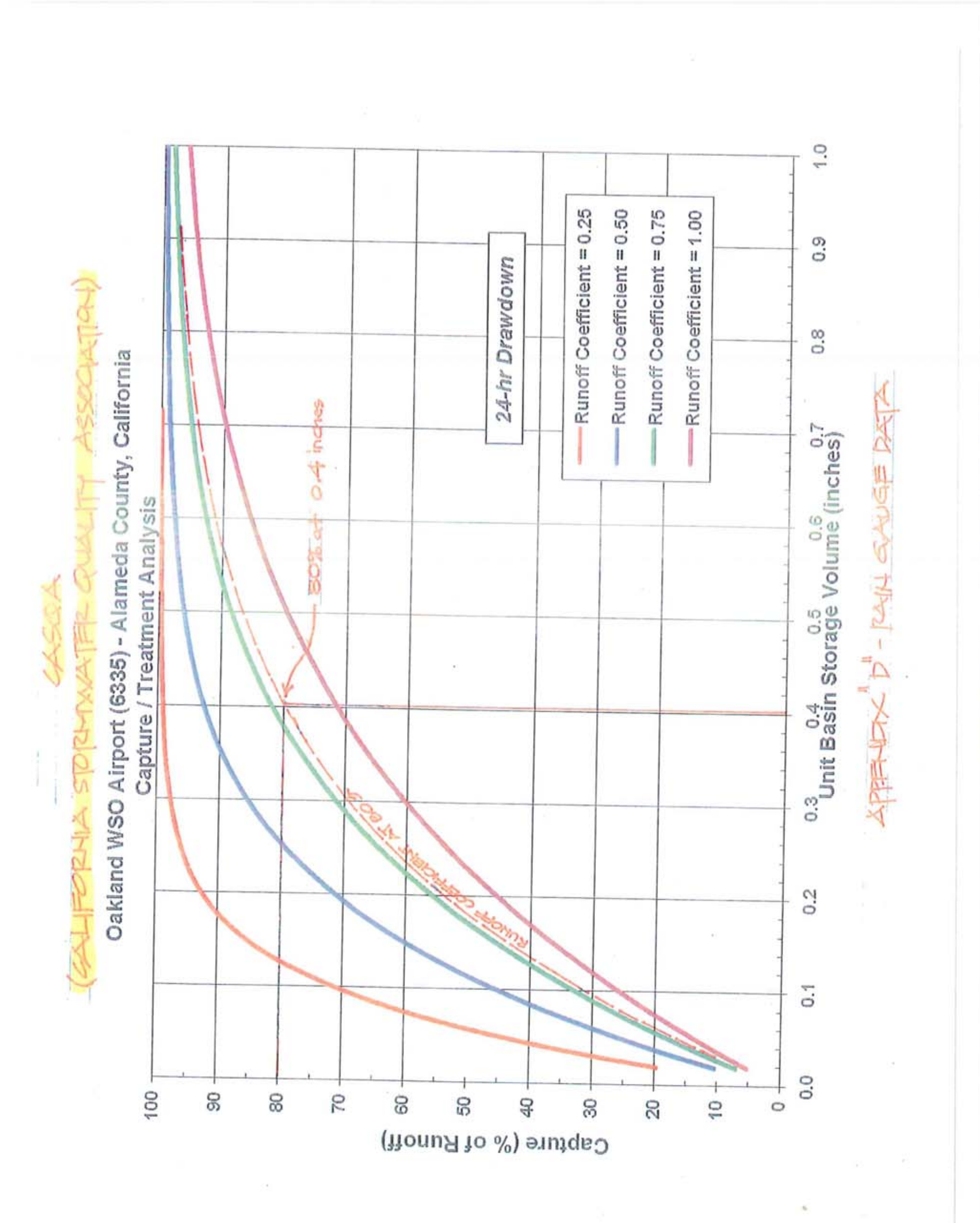
Applicants must use the Treatment Control BMP Selection Worksheet (Appendix F) to select appropriate treatment control BMPs based upon anticipated pollutants and downstream conditions of concern. After the treatment control BMPs are selected, applicants must properly size the treatment control BMPs according to one of the Numeric Sizing Treatment Standards in Table 3. Treatment efficiencies can also be realized by locating treatment controls strategically within a drainage basin without being limited by the project boundary.

Runoff Coefficients For Built-Up Areas

Type of Development	Coefficient	
	Mild Slope	Steep Slope
Low-Density Residential 1-3 Units/Acre	0.40	0.60
Medium Density Residential 4-9 Units/Acre	0.45	0.65
High Density Residential 10 or More Units/Acre	0.60	0.75
Limited Industrial	0.60	0.80
Industrial	0.75	0.90
Commercial ← USE →	0.80	0.90
Schools	0.45	0.65
Parks	0.25	0.50

Figure 3.1

→ NAPA COUNTY ROAD & STREET STANDARDS


CASQA
(CALIFORNIA STORMWATER QUALITY ASSOCIATION)
Oakland WSO Airport (6335) - Alameda County, California
Capture / Treatment Analysis
24-hr Drawdown
Runoff Coefficient = 0.25
Runoff Coefficient = 0.50
Runoff Coefficient = 0.75
Runoff Coefficient = 1.00
80% at 0.4 inches
RUNOFF COEFFICIENT AT 80%
Capture (% of Runoff)
Unit Basin Storage Volume (inches)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
10
20
30
40
50
60
70
80
90
100
APPENDIX "D" - RAIN GAUGE DATA

CHAPTER 9.7

Bioretention TC-32

Design Considerations

- Soil for Infiltration
- Tributary Area
- Slope
- Aesthetics
- Environmental Side-effects

Description

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

California Experience

None documented. Bioretention has been used as a stormwater BMP since 1992. In addition to Prince George's County, MD and Alexandria, VA, bioretention has been used successfully at urban and suburban areas in Montgomery County, MD; Baltimore County, MD; Chesterfield County, VA; Prince William County, VA; Smith Mountain Lake State Park, VA; and Cary, NC.

Advantages

- Bioretention provides stormwater treatment that enhances the quality of downstream water bodies by temporarily storing runoff in the BMP and releasing it over a period of four days to the receiving water (EPA, 1999).
- The vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

Limitations

- The bioretention BMP is not recommended for areas with slopes greater than 20% or where mature tree removal would

Targeted Constituents

	Constituent	Effectiveness
☑	Sediment	■
☑	Nutrients	▲
☑	Trash	■
☑	Metals	■
☑	Bacteria	■
☑	Oil and Grease	■
☑	Organics	■

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

CASQA

be required since clogging may result, particularly if the BMP receives runoff with high sediment loads (EPA, 1999).

- Bioretention is not a suitable BMP at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
- By design, bioretention BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water.
- In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

Design and Sizing Guidelines

- The bioretention area should be sized to capture the design storm runoff.
- In areas where the native soil permeability is less than 0.5 in/hr an underdrain should be provided.
- Recommended minimum dimensions are 15 feet by 40 feet, although the preferred width is 25 feet. Excavated depth should be 4 feet.
- Area should drain completely within 72 hours.
- Approximately 1 tree or shrub per 50 ft² of bioretention area should be included.
- Cover area with about 3 inches of mulch.

Construction/Inspection Considerations

Bioretention area should not be established until contributing watershed is stabilized.

Performance

Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization (EPA, 1999). Adsorption is the process whereby particulate pollutants attach to soil (e.g., clay) or vegetation surfaces. Adequate contact time between the surface and pollutant must be provided for in the design of the system for this removal process to occur. Thus, the infiltration rate of the soils must not exceed those specified in the design criteria or pollutant removal may decrease. Pollutants removed by adsorption include metals, phosphorus, and hydrocarbons. Filtration occurs as runoff passes through the bioretention area media, such as the sand bed, ground cover, and planting soil.

Common particulates removed from stormwater include particulate organic matter, phosphorus, and suspended solids. Biological processes that occur in wetlands result in pollutant uptake by plants and microorganisms in the soil. Plant growth is sustained by the uptake of nutrients from the soils, with woody plants locking up these nutrients through the seasons. Microbial activity within the soil also contributes to the removal of nitrogen and organic matter. Nitrogen is removed by nitrifying and denitrifying bacteria, while aerobic bacteria are responsible for the decomposition of the organic matter. Microbial processes require oxygen and can result in depleted oxygen levels if the bioretention area is not adequately aerated. Sedimentation occurs in the swale or ponding area as the velocity slows and solids fall out of suspension.

The removal effectiveness of bioretention has been studied during field and laboratory studies conducted by the University of Maryland (Davis et al, 1998). During these experiments, synthetic stormwater runoff was pumped through several laboratory and field bioretention areas to simulate typical storm events in Prince George's County, MD. Removal rates for heavy metals and nutrients are shown in Table 1.

Table 1 Laboratory and Estimated Bioretention Davis et al. (1998); PGDER (1993)

Pollutant	Removal Rate
Total Phosphorus	70-83%
Metals (Cu, Zn, Pb)	93-98%
TKN	68-80%
Total Suspended Solids	90%
Organics	90%
Bacteria	90%

Results for both the laboratory and field experiments were similar for each of the pollutants analyzed. Doubling or halving the influent pollutant levels had little effect on the effluent pollutants concentrations (Davis et al, 1998).

The microbial activity and plant uptake occurring in the bioretention area will likely result in higher removal rates than those determined for infiltration BMPs.

Siting Criteria

Bioretention BMPs are generally used to treat stormwater from impervious surfaces at commercial, residential, and industrial areas (EPA, 1999). Implementation of bioretention for stormwater management is ideal for median strips, parking lot islands, and swales. Moreover, the runoff in these areas can be designed to either divert directly into the bioretention area or convey into the bioretention area by a curb and gutter collection system.

The best location for bioretention areas is upland from inlets that receive sheet flow from graded areas and at areas that will be excavated (EPA, 1999). In order to maximize treatment effectiveness, the site must be graded in such a way that minimizes erosive conditions as sheet flow is conveyed to the treatment area. Locations where a bioretention area can be readily incorporated into the site plan without further environmental damage are preferred. Furthermore, to effectively minimize sediment loading in the treatment area, bioretention only should be used in stabilized drainage areas.

Additional Design Guidelines

The layout of the bioretention area is determined after site constraints such as location of utilities, underlying soils, existing vegetation, and drainage are considered (EPA, 1999). Sites with loamy sand soils are especially appropriate for bioretention because the excavated soil can be backfilled and used as the planting soil, thus eliminating the cost of importing planting soil.

The use of bioretention may not be feasible given an unstable surrounding soil stratum, soils with clay content greater than 25 percent, a site with slopes greater than 20 percent, and/or a site with mature trees that would be removed during construction of the BMP.

Bioretention can be designed to be off-line or on-line of the existing drainage system (EPA, 1999). The drainage area for a bioretention area should be between 0.1 and 0.4 hectares (0.25 and 1.0 acres). Larger drainage areas may require multiple bioretention areas. Furthermore, the maximum drainage area for a bioretention area is determined by the expected rainfall intensity and runoff rate. Stabilized areas may erode when velocities are greater than 5 feet per second (1.5 meter per second). The designer should determine the potential for erosive conditions at the site.

The size of the bioretention area, which is a function of the drainage area and the runoff generated from the area is sized to capture the water quality volume.

The recommended minimum dimensions of the bioretention area are 15 feet (4.6 meters) wide by 40 feet (12.2 meters) long, where the minimum width allows enough space for a dense, randomly-distributed area of trees and shrubs to become established. Thus replicating a natural forest and creating a microclimate, thereby enabling the bioretention area to tolerate the effects of heat stress, acid rain, runoff pollutants, and insect and disease infestations which landscaped areas in urban settings typically are unable to tolerate. The preferred width is 25 feet (7.6 meters), with a length of twice the width. Essentially, any facilities wider than 20 feet (6.1 meters) should be twice as long as they are wide, which promotes the distribution of flow and decreases the chances of concentrated flow.

In order to provide adequate storage and prevent water from standing for excessive periods of time the ponding depth of the bioretention area should not exceed 6 inches (15 centimeters). Water should not be left to stand for more than 72 hours. A restriction on the type of plants that can be used may be necessary due to some plants' water intolerance. Furthermore, if water is left standing for longer than 72 hours mosquitoes and other insects may start to breed.

The appropriate planting soil should be backfilled into the excavated bioretention area. Planting soils should be sandy loam, loamy sand, or loam texture with a clay content ranging from 10 to 25 percent.

Generally the soil should have infiltration rates greater than 0.5 inches (1.25 centimeters) per hour, which is typical of sandy loams, loamy sands, or loams. The pH of the soil should range between 5.5 and 6.5, where pollutants such as organic nitrogen and phosphorus can be adsorbed by the soil and microbial activity can flourish. Additional requirements for the planting soil include a 1.5 to 3 percent organic content and a maximum 500 ppm concentration of soluble salts.

Soil tests should be performed for every 500 cubic yards (382 cubic meters) of planting soil, with the exception of pH and organic content tests, which are required only once per bioretention area (EPA, 1999). Planting soil should be 4 inches (10.1 centimeters) deeper than the bottom of the largest root ball and 4 feet (1.2 meters) altogether. This depth will provide adequate soil for the plants' root systems to become established, prevent plant damage due to severe wind, and provide adequate moisture capacity. Most sites will require excavation in order to obtain the recommended depth.

Planting soil depths of greater than 4 feet (1.2 meters) may require additional construction practices such as shoring measures (EPA, 1999). Planting soil should be placed in 18 inches or greater lifts and lightly compacted until the desired depth is reached. Since high canopy trees may be destroyed during maintenance the bioretention area should be vegetated to resemble a terrestrial forest community ecosystem that is dominated by understory trees. Three species each of both trees and shrubs are recommended to be planted at a rate of 2500 trees and shrubs per hectare (1000 per acre). For instance, a 15 foot (4.6 meter) by 40 foot (12.2 meter) bioretention area (600 square feet or 55.75 square meters) would require 14 trees and shrubs. The shrub-to-tree ratio should be 2:1 to 3:1.

Trees and shrubs should be planted when conditions are favorable. Vegetation should be watered at the end of each day for fourteen days following its planting. Plant species tolerant of pollutant loads and varying wet and dry conditions should be used in the bioretention area.

The designer should assess aesthetics, site layout, and maintenance requirements when selecting plant species. Adjacent non-native invasive species should be identified and the designer should take measures, such as providing a soil breach to eliminate the threat of these species invading the bioretention area. Regional landscaping manuals should be consulted to ensure that the planting of the bioretention area meets the landscaping requirements established by the local authorities. The designers should evaluate the best placement of vegetation within the bioretention area. Plants should be placed at irregular intervals to replicate a natural forest. Trees should be placed on the perimeter of the area to provide shade and shelter from the wind. Trees and shrubs can be sheltered from damaging flows if they are placed away from the path of the incoming runoff. In cold climates, species that are more tolerant to cold winds, such as evergreens, should be placed in windier areas of the site.

Following placement of the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses or legumes can be planted at the beginning of the growing season. Mulch should be placed immediately after trees and shrubs are planted. Two to 3 inches (5 to 7.6 cm) of commercially-available fine shredded hardwood mulch or shredded hardwood chips should be applied to the bioretention area to protect from erosion.

Maintenance

The primary maintenance requirement for bioretention areas is that of inspection and repair or replacement of the treatment area's components. Generally, this involves nothing more than the routine periodic maintenance that is required of any landscaped area. Plants that are appropriate for the site, climatic, and watering conditions should be selected for use in the bioretention cell. Appropriately selected plants will aide in reducing fertilizer, pesticide, water, and overall maintenance requirements. Bioretention system components should blend over time through plant and root growth, organic decomposition, and the development of a natural soil horizon. These biologic and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Routine maintenance should include a biannual health evaluation of the trees and shrubs and subsequent removal of any dead or diseased vegetation (EPA, 1999). Diseased vegetation should be treated as needed using preventative and low-toxic measures to the extent possible. BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water. Routine inspections for areas of standing water within the BMP and corrective measures to restore proper infiltration rates are necessary to prevent creating mosquito and other vector habitat. In addition, bioretention BMPs are susceptible to invasion by aggressive plant species such as cattails, which increase the chances of water standing and subsequent vector production if not routinely maintained.

In order to maintain the treatment area's appearance it may be necessary to prune and weed. Furthermore, mulch replacement is suggested when erosion is evident or when the site begins to look unattractive. Specifically, the entire area may require mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas. Mulch replacement should be done prior to the start of the wet season.

New Jersey's Department of Environmental Protection states in their bioretention systems standards that accumulated sediment and debris removal (especially at the inflow point) will normally be the primary maintenance function. Other potential tasks include replacement of dead vegetation, soil pH regulation, erosion repair at inflow points, mulch replenishment, unclogging the underdrain, and repairing overflow structures. There is also the possibility that the cation exchange capacity of the soils in the cell will be significantly reduced over time. Depending on pollutant loads, soils may need to be replaced within 5-10 years of construction (LID, 2000).

Cost

Construction Cost

Construction cost estimates for a bioretention area are slightly greater than those for the required landscaping for a new development (EPA, 1999). A general rule of thumb (Coffman, 1999) is that residential bioretention areas average about $3 to $4 per square foot, depending on soil conditions and the density and types of plants used. Commercial, industrial and institutional site costs can range between $10 to $40 per square foot, based on the need for control structures, curbing, storm drains and underdrains.

Retrofitting a site typically costs more, averaging $6,500 per bioretention area. The higher costs are attributed to the demolition of existing concrete, asphalt, and existing structures and the replacement of fill material with planting soil. The costs of retrofitting a commercial site in Maryland, Kettering Development, with 15 bioretention areas were estimated at $111,600.

In any bioretention area design, the cost of plants varies substantially and can account for a significant portion of the expenditures. While these cost estimates are slightly greater than those of typical landscaping treatment (due to the increased number of plantings, additional soil excavation, backfill material, use of underdrains etc.), those landscaping expenses that would be required regardless of the bioretention installation should be subtracted when determining the net cost.

Perhaps of most importance, however, the cost savings compared to the use of traditional structural stormwater conveyance systems makes bioretention areas quite attractive financially. For example, the use of bioretention can decrease the cost required for constructing stormwater conveyance systems at a site. A medical office building in Maryland was able to reduce the amount of storm drain pipe that was needed from 800 to 230 feet - a cost savings of $24,000 (PGDER, 1993). And a new residential development spent a total of approximately $100,000 using bioretention cells on each lot instead of nearly $400,000 for the traditional stormwater ponds that were originally planned (Rappahanock,). Also, in residential areas, stormwater management controls become a part of each property owner's landscape, reducing the public burden to maintain large centralized facilities.

Maintenance Cost

The operation and maintenance costs for a bioretention facility will be comparable to those of typical landscaping required for a site. Costs beyond the normal landscaping fees will include the cost for testing the soils and may include costs for a sand bed and planting soil.

References and Sources of Additional Information

Coffman, L.S., R. Goo and R. Frederick, 1999: Low impact development: an innovative alternative approach to stormwater management. Proceedings of the 26th Annual Water Resources Planning and Management Conference ASCE, June 6-9, Tempe, Arizona.

Davis, A.P., Shokouhian, M., Sharma, H. and Minami, C., "Laboratory Study of Biological Retention (Bioretention) for Urban Stormwater Management," *Water Environ. Res.*, 73(1), 5-14 (2001).

Davis, A.P., Shokouhian, M., Sharma, H., Minami, C., and Winogradoff, D. "Water Quality Improvement through Bioretention: Lead, Copper, and Zinc," *Water Environ. Res.*, accepted for publication, August 2002.

Kim, H., Seagren, E.A., and Davis, A.P., "Engineered Bioretention for Removal of Nitrate from Stormwater Runoff," *WEFTEC 2000 Conference Proceedings on CDROM Research Symposium, Nitrogen Removal*, Session 19, Anaheim CA, October 2000.

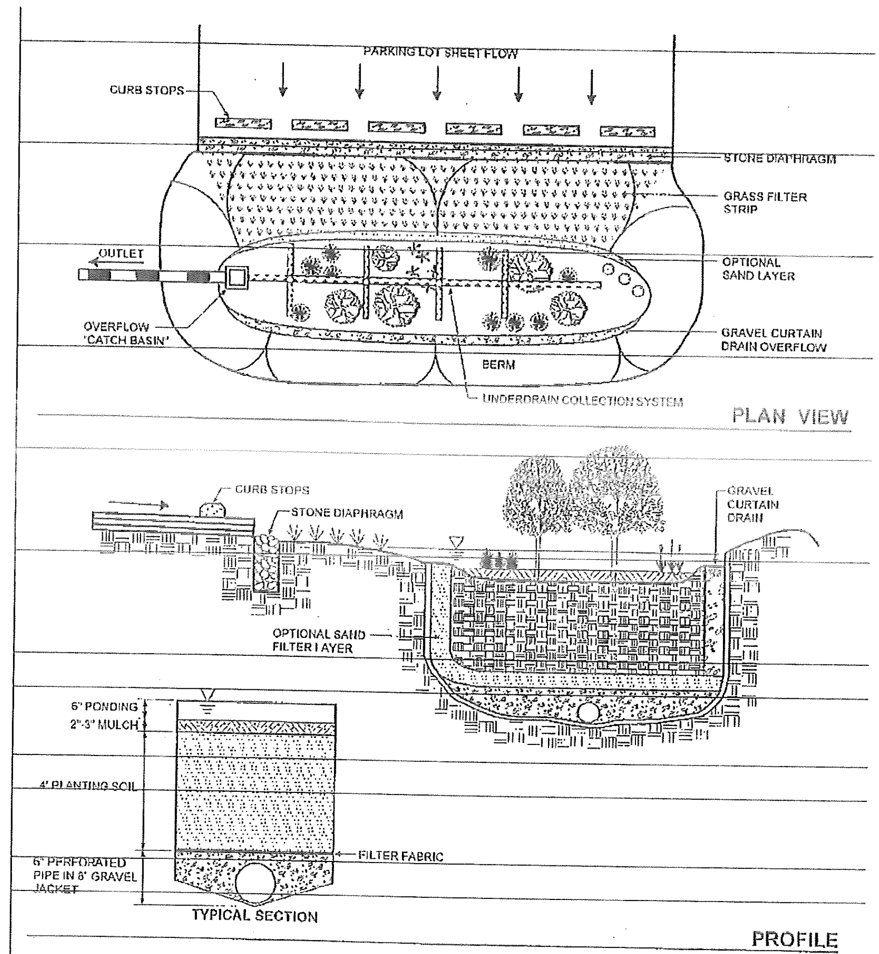
Hsieh, C.-h. and Davis, A.P. "Engineering Bioretention for Treatment of Urban Stormwater Runoff," *Watersheds 2002, Proceedings on CDROM Research Symposium*, Session 15, Ft. Lauderdale, FL, Feb. 2002.

Prince George's County Department of Environmental Resources (PGDER), 1993. Design Manual for Use of *Bioretention in Stormwater Management*. Division of Environmental Management, Watershed Protection Branch. Landover, MD.

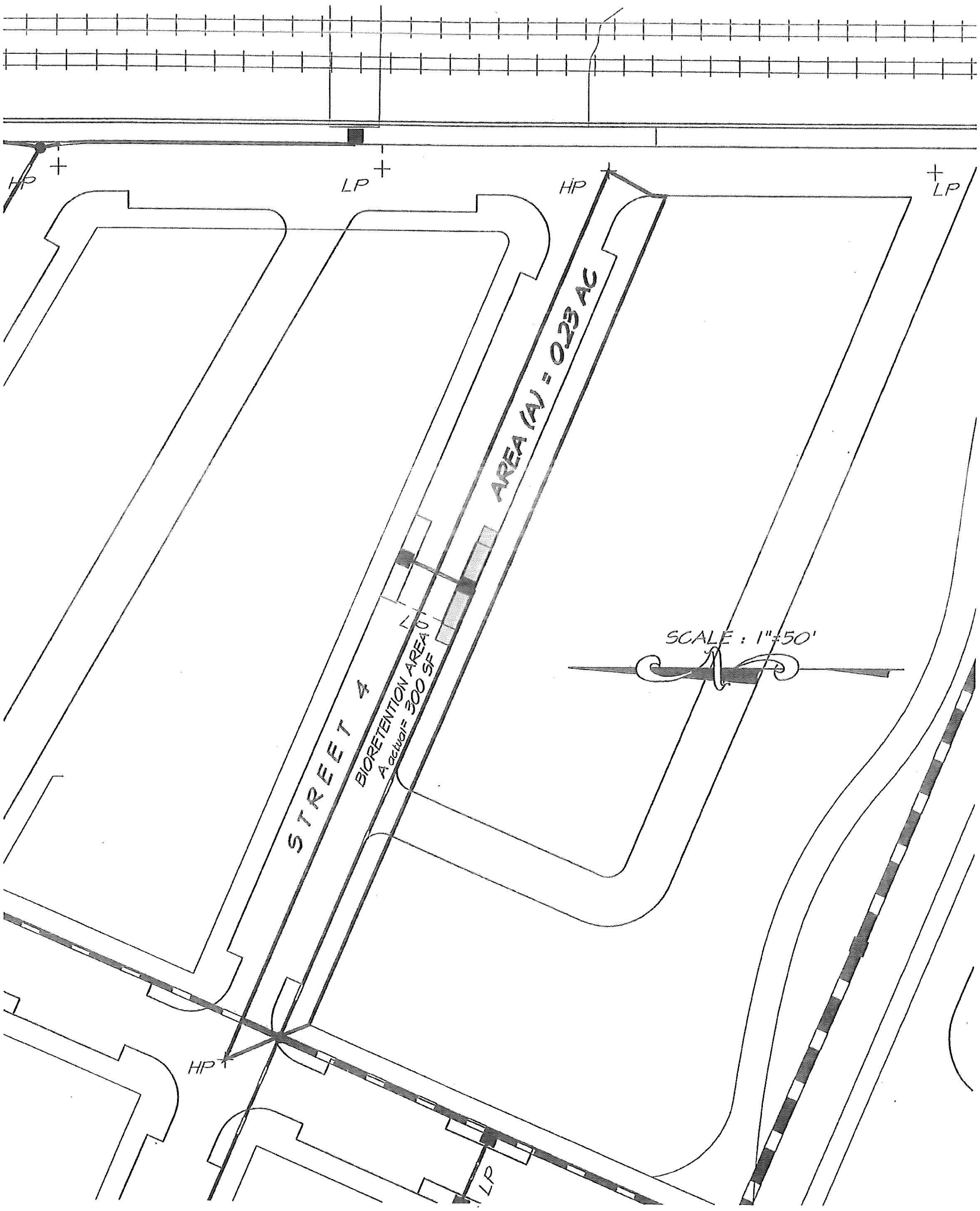
U.S. EPA Office of Water, 1999. Stormwater Technology Fact Sheet: Bioretention. EPA 832-F-99-012.

Weinstein, N. Davis, A.P. and Veeramachaneni, R. "Low Impact Development (LID) Stormwater Management Approach for the Control of Diffuse Pollution from Urban Roadways," *5th International Conference Diffuse/Nonpoint Pollution and Watershed Management Proceedings*, C.S. Melching and Emre Alp, Eds. 2001 International Water Association

TC-32 Bioretention



Schematic of a Bioretention Facility (MDE, 2000)



PROPOSED BMP EXHIBIT (AREA 1) FOR BIORETENTION AREA BMP CALCULATION

BMP Design Flow Calculation (Area 1)

$V_{BMP} = (A) \times (D)$

WHERE : V_{BMP} = REQUIRED TREATMENT VOLUME
A = 0.23 ac (SEE ATTACHED, WATERSHED AREA)
D = 0.40 in (SEE ATTACHED, CASQA CURVE))

$$V_{BMP} = (0.23\ ac) \times \frac{43{,}560\ ft^2}{1\ ac} \times (0.40\ in) \times \frac{1\ ft}{12\ in}$$

$= \boxed{334\ ft^3}$ ← REQUIRED TREATMENT VOLUME

$V_{BMP} = (A_{BMP}) \times (D_{BMP}) \times (P)$

$$A_{BMP} = \frac{V_{BMP}}{(D_{BMP}) \times (P)}$$

WHERE : A_{BMP} = MINIMUM AREA OF THE BMP REQUIRED
V_{BMP} = 334 ft^3 (SEE ABOVE)
D_{BMP} = 3.5 ft (ASSUMED DEPTH OF BMP)
P = 0.33 (ASSUMED POROSITY OF MATERIAL)

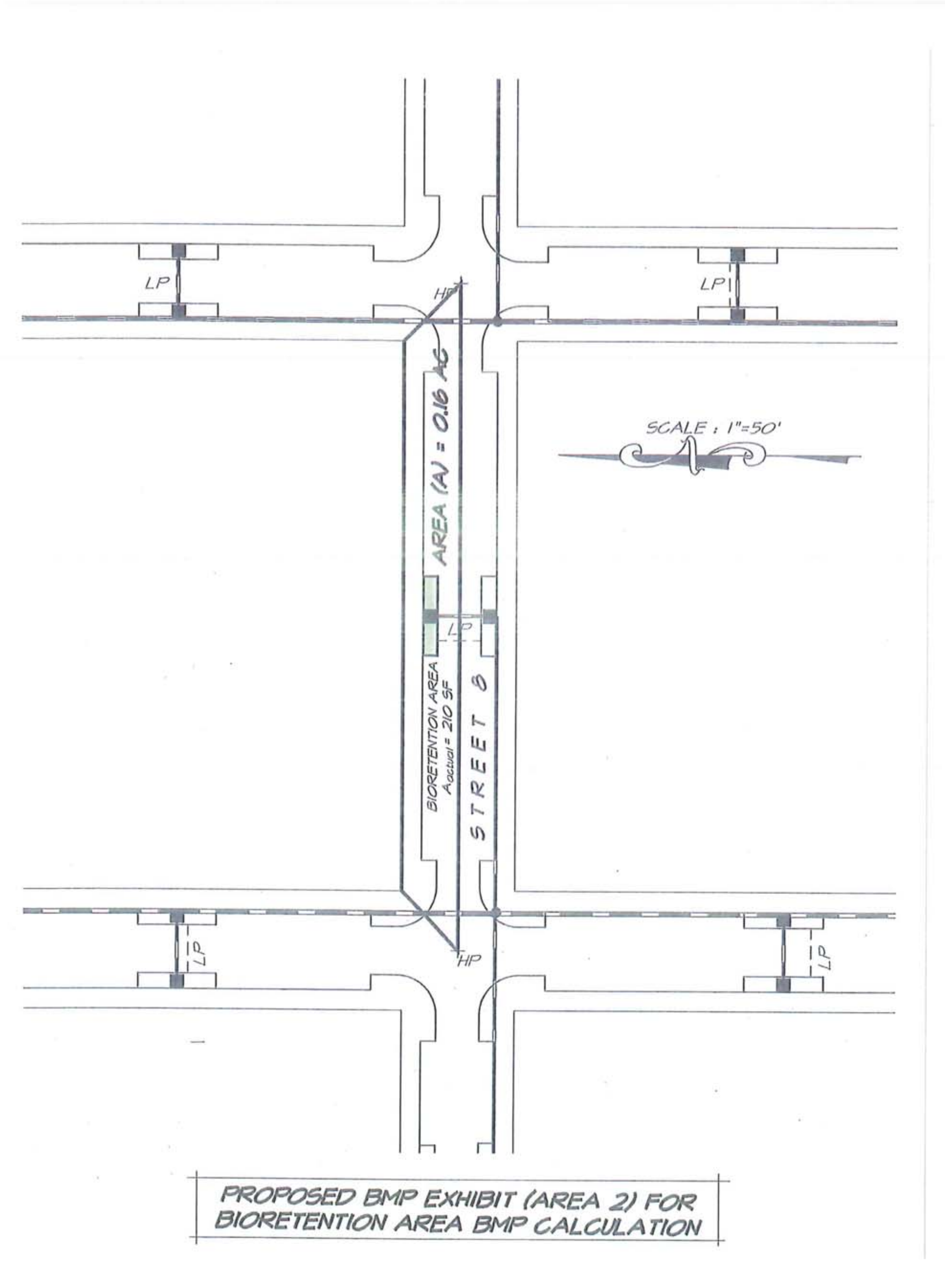
$$A_{BMP} = \frac{334}{(3.5) \times (0.33)}$$

$= \boxed{289\ SF}$ ← MINIMUM BMP AREA

$A_{ACTUAL} = 6' \times 50' = 300\ SF$ (SEE PREVIOUS SHEET)

SINCE: $A_{ACTUAL} > A_{BMP}$

300 SF > 289 SF ------- OK!


LP
LP
HP
AREA (A) = 0.16 AC
SCALE : 1"=50'
LP
BIORETENTION AREA
Aactual = 210 SF
STREET B
HP
LP
LP
PROPOSED BMP EXHIBIT (AREA 2) FOR
BIORETENTION AREA BMP CALCULATION

BMP Design Flow Calculation (Area 2)

$V_{BMP} = (A) \times (D)$

WHERE : V_{BMP} = REQUIRED TREATMENT VOLUME
A = 0.16 ac (SEE ATTACHED, WATERSHED AREA)
D = 0.40 in (SEE ATTACHED, CASQA CURVE))

$$V_{BMP} = (0.16\ ac) \times \frac{43{,}560\ ft^2}{1\ ac} \times (0.40\ in) \times \frac{1\ ft}{12\ in}$$

$= \boxed{232\ ft^3}$ ← REQUIRED TREATMENT VOLUME

$V_{BMP} = (A_{BMP}) \times (D_{BMP}) \times (P)$

$$A_{BMP} = \frac{V_{BMP}}{(D_{BMP}) \times (P)}$$

WHERE : A_{BMP} = MINIMUM AREA OF THE BMP REQUIRED
V_{BMP} = 232 ft^3 (SEE ABOVE)
D_{BMP} = 3.5 ft (ASSUMED DEPTH OF BMP)
P = 0.33 (ASSUMED POROSITY OF MATERIAL)

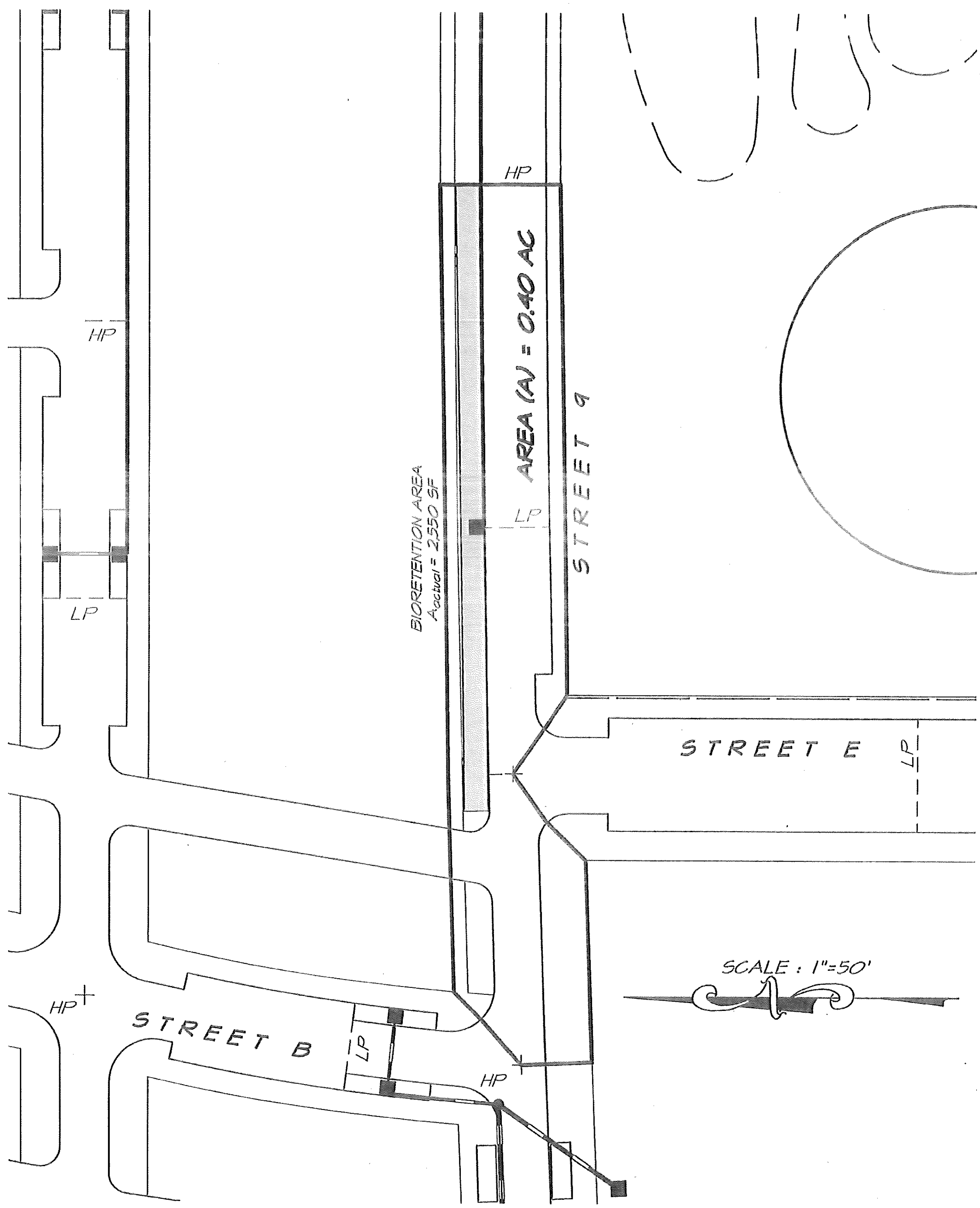
$$A_{BMP} = \frac{232}{(3.5) \times (0.33)}$$

$= \boxed{201\ SF}$ ← MINIMUM BMP AREA

A_{ACTUAL} = 6' x 35' = 210 SF (SEE PREVIOUS SHEET)

SINCE: $A_{ACTUAL} > A_{BMP}$

210 SF > 201 SF ------- OK!



PROPOSED BMP EXHIBIT (AREA 3) FOR BIORETENTION AREA BMP CALCULATION

BMP Design Flow Calculation (Area 3)

$V_{BMP} = (A) \times (D)$

WHERE : V_{BMP} = REQUIRED TREATMENT VOLUME
A = 0.40 ac (SEE ATTACHED, WATERSHED AREA)
D = 0.40 in (SEE ATTACHED, CASQA CURVE))

$$V_{BMP} = (0.40\ ac) \times \frac{43{,}560\ ft^2}{1\ ac} \times (0.40\ in) \times \frac{1\ ft}{12\ in}$$

$= \boxed{581\ ft^3}$ ← REQUIRED TREATMENT VOLUME

$V_{BMP} = (A_{BMP}) \times (D_{BMP}) \times (P)$

$$A_{BMP} = \frac{V_{BMP}}{(D_{BMP}) \times (P)}$$

WHERE : A_{BMP} = MINIMUM AREA OF THE BMP REQUIRED
V_{BMP} = 581 ft^3 (SEE ABOVE)
D_{BMP} = 3.5 ft (ASSUMED DEPTH OF BMP)
P = 0.33 (ASSUMED POROSITY OF MATERIAL)

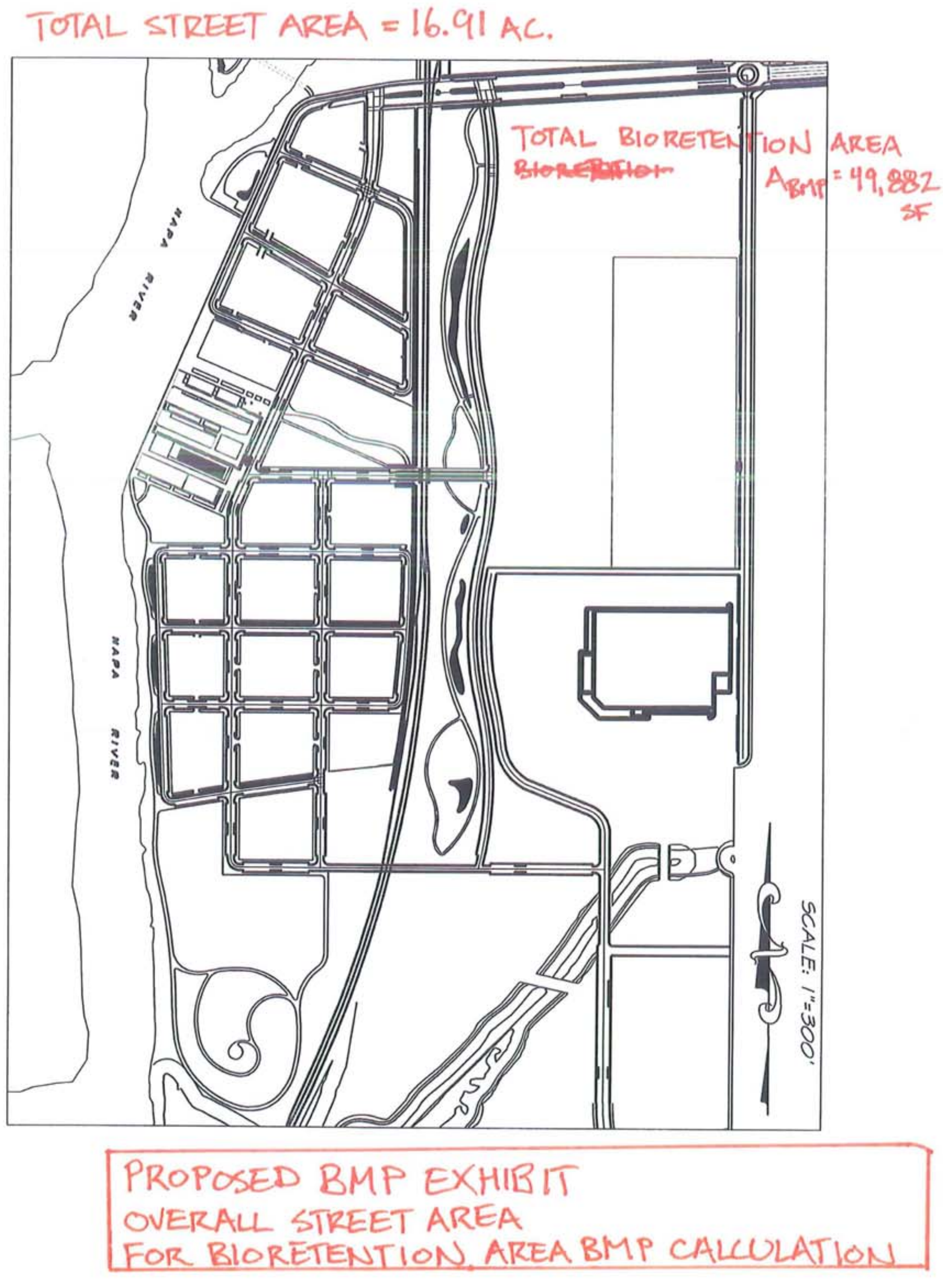
$$A_{BMP} = \frac{581}{(3.5) \times (0.33)}$$

$= \boxed{503\ SF}$ ← MINIMUM BMP AREA

A_{ACTUAL} = 10' x 255' = 2,550 SF (SEE PREVIOUS SHEET)

SINCE: $A_{ACTUAL} > A_{BMP}$

2,550 SF > 503 SF -------- OK!


TOTAL STREET AREA = 16.91 AC.
TOTAL BIORETENTION AREA
A_{BMP} = 49,882 SF
NAPA RIVER
NAPA RIVER
SCALE: 1"=300'
PROPOSED BMP EXHIBIT
OVERALL STREET AREA
FOR BIORETENTION AREA BMP CALCULATION

BMP DESIGN FLOW CALCULATION
(OVERALL STREET AREA)

$V_{BMP} = (A) \times (D)$

WHERE: V_{BMP} = Required Treatment volume
A = 16.91 Ac (see attached, watershed area)
D = 0.40 in (see attached, CASQA curve)

$V_{BMP} = (16.91\ Ac) \times 43560\ ft^2/Ac \times (0.40'') \times 1\ ft/12\ in$

$= \boxed{24553\ ft.^3}$ ← REQ'D TREATMENT VOLUME

$V_{BMP} = (A_{BMP}) \times (D_{BMP}) \times (P)$

$A_{BMP} = V_{BMP} / (D_{BMP} \times P)$

WHERE: A_{BMP} = minimum area of BMP required
V_{BMP} = 24,553 ft^3 (see above)
D_{BMP} = 3.5 FT (ASSUMED DEPTH)
P = 0.33 (ASSUMED POROSITY OF MATERIAL)

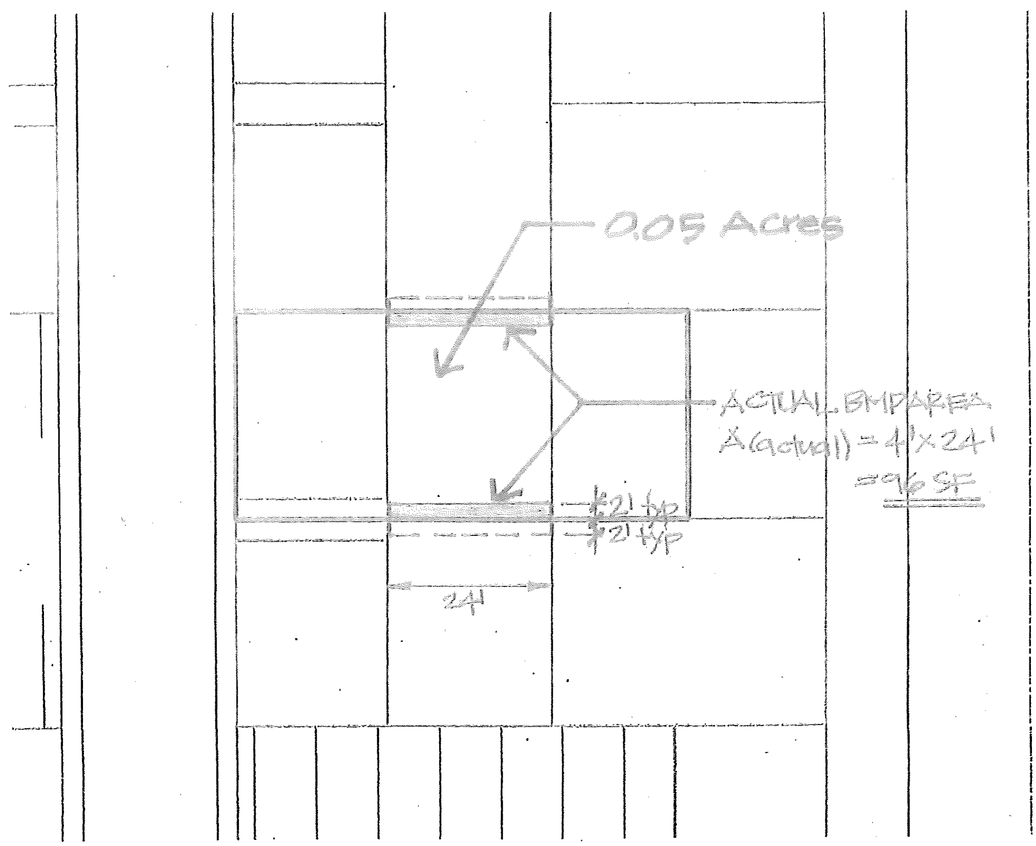
$A_{BMP} = 24{,}553\ ft^3 / (3.5' \times 0.33)$

$= \boxed{21{,}258\ SF}$ ← MINIMUM BMP AREA

A_{ACTUAL} = 49,882 SF (SEE PREVIOUS SHEET)

SINCE $A_{ACTUAL} > A_{BMP}$ — OK!

PROPOSED BMP EXHIBIT (SIDEYARD SWALE/BIORETENTION)
FOR BIORETENTION AREA BMP CALCULATION



SIDEYARD SWALE/BIORETENTION
SCALE: 1" = 20'

BMP Design Flow Calculation (Sideyard Swale/Bioretention)

$V_{BMP} = (A) \times (D)$

WHERE : V_{BMP} = REQUIRED TREATMENT VOLUME
A = 0.05 ac (SEE ATTACHED, WATERSHED AREA)
D = 0.40 in (SEE ATTACHED, CASQA CURVE))

$$V_{BMP} = (0.05\ ac) \times \frac{43{,}560\ ft^2}{1\ ac} \times (0.40\ in) \times \frac{1\ ft}{12\ in}$$

$= \boxed{73\ ft^3}$ ← REQUIRED TREATMENT VOLUME

$V_{BMP} = (A_{BMP}) \times (D_{BMP}) \times (P)$

$$A_{BMP} = \frac{V_{BMP}}{(D_{BMP}) \times (P)}$$

WHERE : A_{BMP} = MINIMUM AREA OF THE BMP REQUIRED
V_{BMP} = 73 ft^3 (SEE ABOVE)
D_{BMP} = 2.5 ft (ASSUMED DEPTH OF BMP)
P = 0.33 (ASSUMED POROSITY OF MATERIAL)

$$A_{BMP} = \frac{73}{(2.5) \times (0.33)}$$

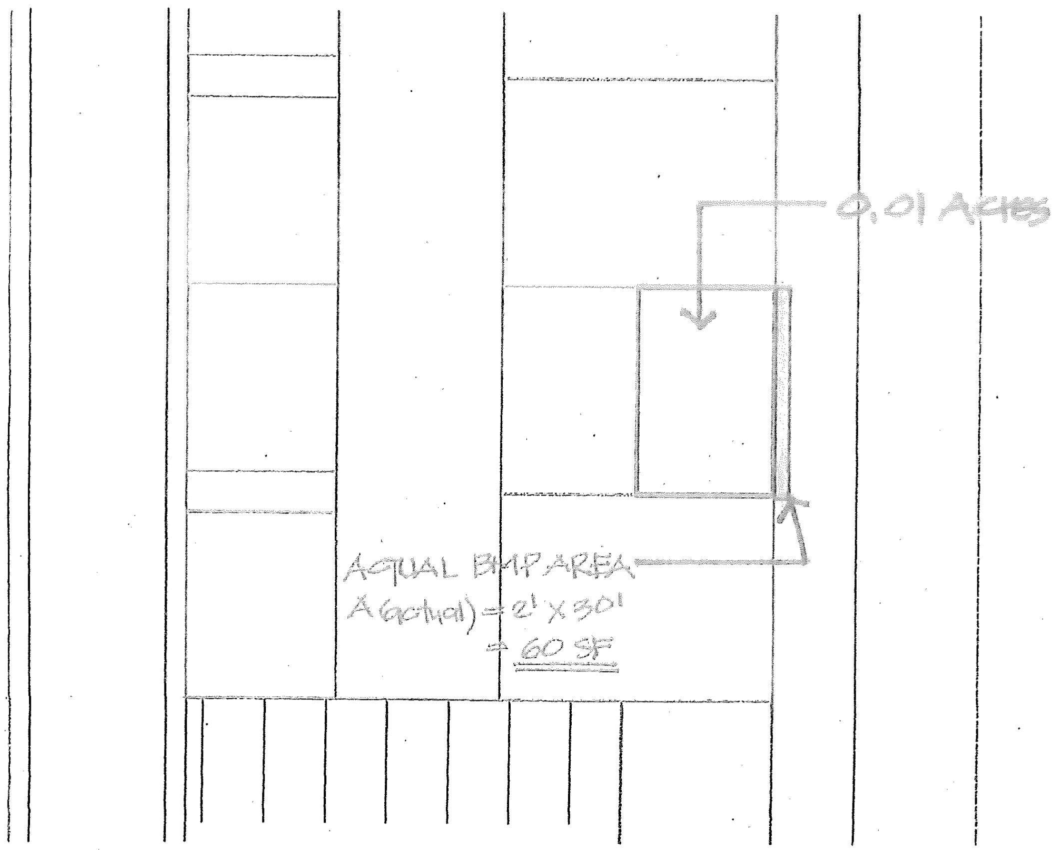
$= \boxed{89\ SF}$ ← MINIMUM BMP AREA

A_{ACTUAL} = 96 SF (SEE PREVIOUS SHEET)

SINCE: $A_{ACTUAL} > A_{BMP}$

96 SF > 89 SF -------- OK!

PROPOSED BMP EXHIBIT (FLOW-THROUGH PLANTER)
FOR BIORETENTION AREA BMP CALCULATION



FLOW THROUGH PLANTER
SCALE: 1" = 20'

BMP Design Flow Calculation (Flow-through Planter)

$V_{BMP} = (A) \times (D)$

WHERE : V_{BMP} = REQUIRED TREATMENT VOLUME
A = 0.01 ac (SEE ATTACHED, WATERSHED AREA)
D = 0.40 in (SEE ATTACHED, CASQA CURVE))

$$V_{BMP} = (0.01 \text{ ac}) \times \frac{43{,}560 \text{ ft}^2}{1 \text{ ac}} \times (0.40 \text{ in}) \times \frac{1 \text{ ft}}{12 \text{ in}}$$

$= \boxed{15 \text{ ft}^3}$ ← REQUIRED TREATMENT VOLUME

$V_{BMP} = (A_{BMP}) \times (D_{BMP}) \times (P)$

$$A_{BMP} = \frac{V_{BMP}}{(D_{BMP}) \times (P)}$$

WHERE : A_{BMP} = MINIMUM AREA OF THE BMP REQUIRED
V_{BMP} = 15 ft^3 (SEE ABOVE)
D_{BMP} = 2.5 ft (ASSUMED DEPTH OF BMP)
P = 0.33 (ASSUMED POROSITY OF MATERIAL)

$$A_{BMP} = \frac{15}{(2.5) \times (0.33)}$$

$= \boxed{18 \text{ SF}}$ ← MINIMUM BMP AREA

A_{ACTUAL} = 60 SF (SEE PREVIOUS SHEET)

SINCE: $A_{ACTUAL} > A_{BMP}$

60 SF > 18 SF -------- OK!

THESE FACT SHEETS WERE TAKEN FROM THE CONTRA COSTA STORMWATER C3 GUIDELINE, APPROVED EQUAL BY NAPA COUNTY PUBLIC WORKS CAN BE USED

Flow-through Planter

City of Portland 2004 *Stormwater Manual*

Flow-through planters are designed to treat and detain runoff without allowing seepage into the underlying soil. They can be used next to buildings and other locations where soil moisture is a potential concern.

Flow-through planters typically receive runoff via downspouts leading from the roofs of adjacent buildings. However, flow-through planters can also be set level with the ground and receive sheet flow. (See the In-Ground Planter fact sheet.)

Pollutants are removed as the runoff passes through the soil layer and is collected in an underlying layer of gravel or drain rock. A perforated pipe underdrain must be piped to a storm drain or other discharge point. An overflow inlet conveys flows which exceed the capacity of the planter.

Design and Construction. Flow-through planters for stormwater treatment only must have a sizing factor (surface area of swale/surface area of tributary impervious area) of at least 0.04. Minimum sizing factors for treatment-plus-flow-control are incorporated into the Program's IMP sizing tool. Plantings should be selected for viability in a well-drained soil. Irrigation is required to maintain plant viability.

Maintenance. Maintain vegetation and irrigation system; inspect periodically and after storms to ensure structural integrity and that planter has not clogged.

Best Uses

- Retention and treatment of roof runoff
- Next to buildings
- Dense urban areas
- Where infiltration is not desired

Advantages

- Can be used next to structures
- Space-efficient
- Versatile
- Can be any shape
- Low maintenance

Limitations

- Requires underdrain
- Requires sufficient head between inlet and underdrain
- Requires careful selection of plant palette
- Must be installed level
- Typically requires irrigation

Contra Costa Clean Water Program

Integrated Management Practice Fact Sheets

Design Checklist for Flow-through Planter

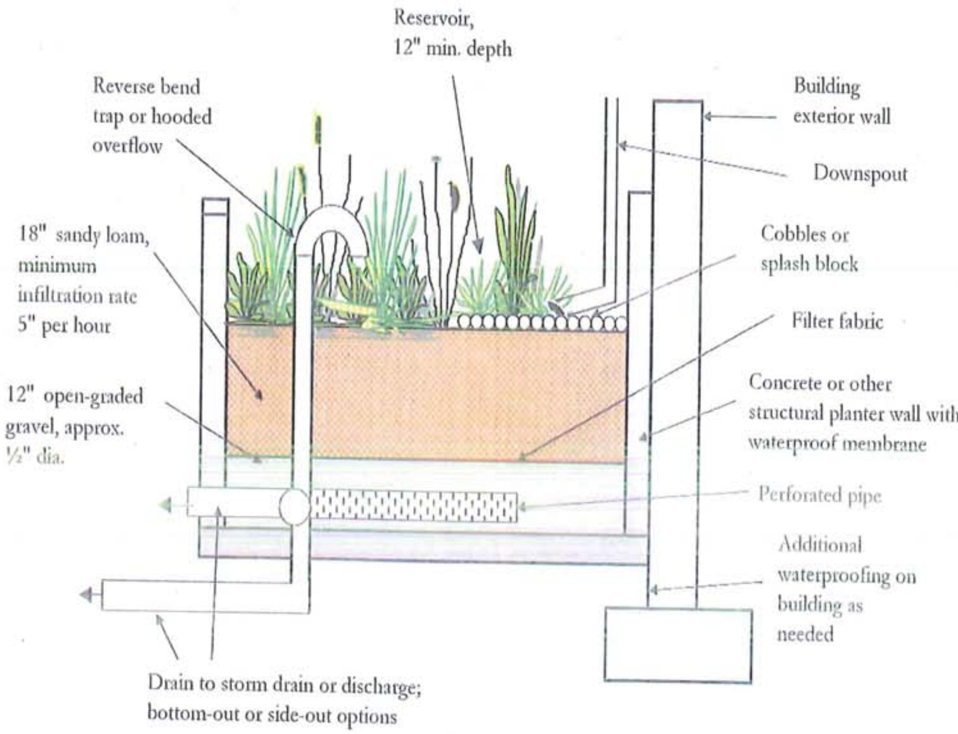
- ☐ Planter is installed level.
- ☐ Overflow adequate to meet municipal drainage requirements
- ☐ Minimum 12" deep reservoir at top of planter
- ☐ 18" deep "sandy loam" soil mix with no more than 5% clay content. Mix should be 50-60% sand, 20-30% compost, and 20-30% topsoil, free of stones, stumps, roots, or similar objects, and also free of noxious weeds.
- ☐ Pea gravel or crushed rock layer beneath soil layer (see below for gravel layer depth requirements).
- ☐ Perforated pipe underdrain with cleanouts and connection to storm drain or discharge point.
- ☐ Adequate head from underdrain to storm drain or discharge point.
- ☐ Waterproofing as required to protect groundwater or building foundations.
- ☐ Splash blocks or cobbles at downspouts and inlet pipes
- ☐ Plants selected for viability and to minimize need for fertilizers and pesticides.
- ☐ Irrigation system with connection to water supply.

Treatment Only design

- ☐ Minimum gravel layer depth 12".
- ☐ Ratio (surface area of planter)/(tributary impervious area) is at least 0.04.

Flow Control and Treatment design

- ☐ Minimum sizing factor depends on geographic location and native soil type; use sizing tool.
- ☐ Minimum gravel layer depth 18" (porosity 0.4).
- ☐ Perforated pipe underdrain with orifice or other control to limit flow rate to the maximum specified by the sizing tool.


Reservoir,
12" min. depth
Reverse bend
trap or hooded
overflow
Building
exterior wall
Downspout
18" sandy loam,
minimum
infiltration rate
5" per hour
Cobbles or
splash block
Filter fabric
12" open-graded
gravel, approx.
½" dia.
Concrete or other
structural planter wall with
waterproof membrane
Perforated pipe
Additional
waterproofing on
building as
needed
Drain to storm drain or discharge;
bottom-out or side-out options

Appendix B

Vegetated Swale

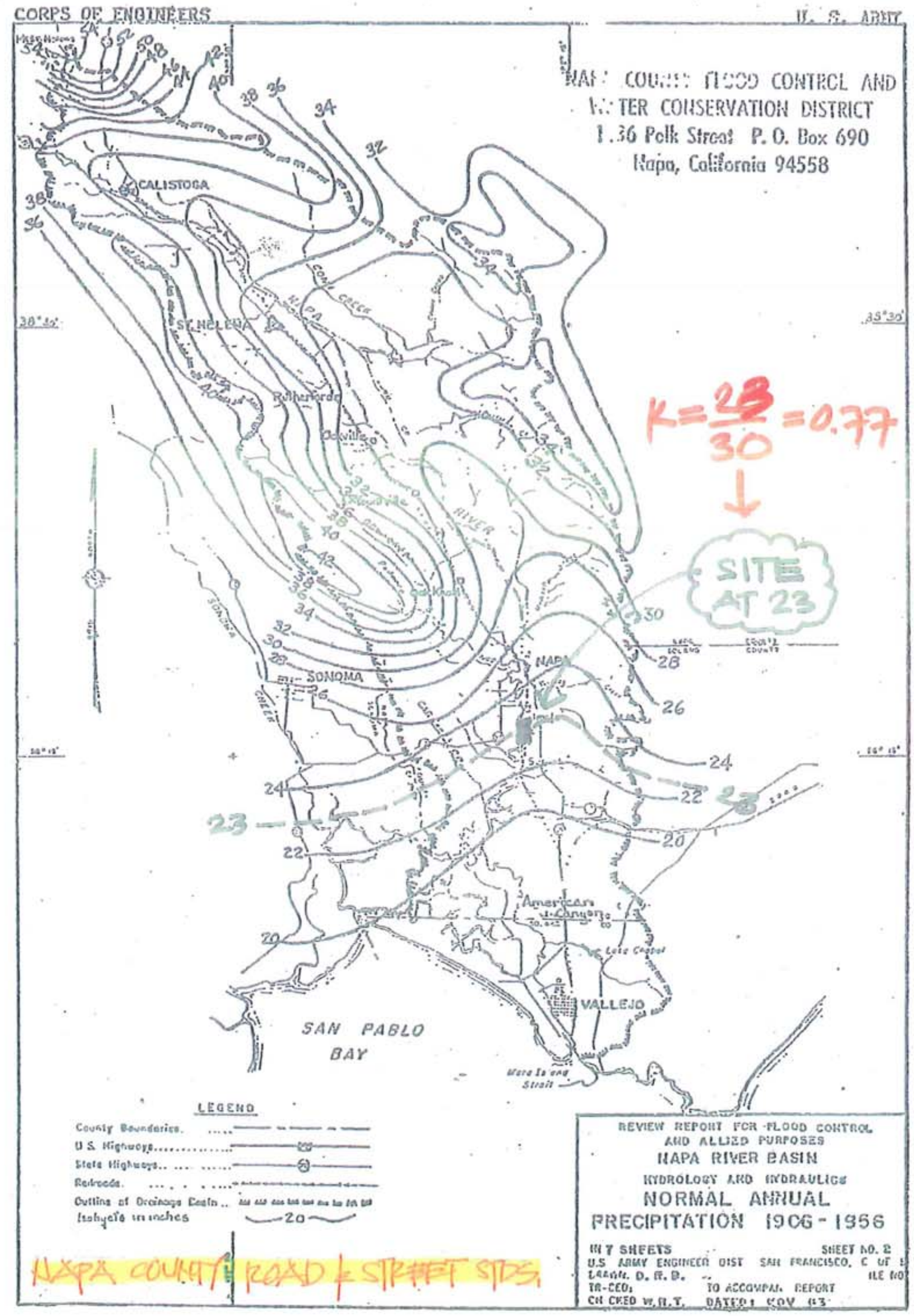
Design Parameters

VEGETATED SWALE BMP CALCULATION

Target Parameters:

1. Minimum Hydraulic Residence Time = 10 minutes
2. Maximum Drainage Area = 10 Acres
3. Maximum Bottom Width = 10 feet
4. Maximum Channel Slope = 2.5%
5. Minimum Channel Length = 100 feet
6. Maximum Channel Side Slope = 3:1 ft/ft
7. Recommended Grass Height = 6 inches
8. Maximum Depth of Flow = 4 inches or 2/3 the "Recommended Grass Height", whichever is lesser
9. Manning's n-value = 0.25
10. Minimum Curb Cut Width to Channel = 12 inches (to prevent clogging)

Reference: California Stormwater Quality Association (CASQA), Section 5.7, TC-30


CORPS OF ENGINEERS
U. S. ARMY
NAPA COUNTY FLOOD CONTROL AND
WATER CONSERVATION DISTRICT
1136 Polk Street P. O. Box 690
Napa, California 94558
K=23/30=0.77
SITE AT 23
CALISTOGA
ST HELENA
Rutherford
Oakville
NAPA
RIVER
SONOMA
NAPA
American Canyon
VALLEJO
SAN PABLO BAY
LEGEND
County Boundaries
U.S. Highways
State Highways
Railroads
Outline of Drainage Basin
Isohyets in inches
NAPA COUNTY ROAD & STREET STDS.
REVIEW REPORT FOR FLOOD CONTROL AND ALLIED PURPOSES
NAPA RIVER BASIN
HYDROLOGY AND HYDRAULICS
NORMAL ANNUAL PRECIPITATION 1906 - 1956
IN 7 SHEETS
SHEET NO. 2
U.S. ARMY ENGINEER DIST SAN FRANCISCO
TO ACCOMPANY REPORT

Runoff Coefficients For Built-Up Areas

Type of Development	Coefficient	
	Mild Slope	Steep Slope
Low-Density Residential 1-3 Units/Acre	0.40	0.60
Medium Density Residential 4-9 Units/Acre	0.45	0.65
High Density Residential 10 or More Units/Acre	0.60	0.75
Limited Industrial	0.60	0.80
Industrial	0.75	0.90
Commercial ← USE →	0.80	0.90
Schools	0.45	0.65
Parks	0.25	0.50

Figure 3.1

NAPA COUNTY ROAD & STREET STANDARDS

Reference Exhibit

Napa County Post-construction Runoff Management
Management Requirements (NCPRMR)
and
California Stormwater Quality Association
(CASQA)

The canopy must not drain onto the fuel dispensing area, and the canopy downspouts must be routed to prevent drainage across the fueling area.

2. All fuel dispensing areas must be paved with Portland cement concrete (or equivalent smooth impervious surface), and the use of asphalt concrete shall be prohibited.
3. All fuel dispensing areas must have a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents runon of storm water to the extent practicable.
4. At a minimum, the concrete fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.
5. Above-ground fuel tanks must be protected with a secondary containment structure of sufficient volume to contain all of the fuel in the event of a tank rupture or leak.

4.3 Treatment Control BMPs

A. Treatment BMP Sizing Standards

After site design and source control BMPs have been incorporated into the project design, priority projects subject to the treatment control requirements (see Table 2) shall design a single or combination of treatment control BMPs designed to infiltrate, filter, and/or treat runoff from the project footprint to one of the "Numeric Sizing Treatment Standards" listed below.

VOLUME

Volume-based BMPs shall be designed to mitigate (infiltrate, filter, or treat) either:

a. The 85th percentile 24-hour runoff event determined as the maximized capture storm water volume for the area, from the formula recommended in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998); or
b. The volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment by the method recommended in California Stormwater Best Management Practices Handbook – Industrial/ Commercial, (2003); or
c. The volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for "treatment" that achieves approximately the same reduction in pollutant loads achieved by the 85th percentile 24-hour runoff event.

Flow

Flow-based BMPs shall be designed to mitigate (infiltrate, filter, or treat) either:

a. The flow of runoff produced from a rain event equal to at least two times the 85th percentile hourly rainfall intensity for the area; or
b. The flow of runoff produced from a rain event that will result in treatment of the same portion of runoff as treated using volumetric standards above.

Applicants must use the Treatment Control BMP Selection Worksheet (Appendix F) to select appropriate treatment control BMPs based upon anticipated pollutants and downstream conditions of concern. After the treatment control BMPs are selected, applicants must properly size the treatment control BMPs according to one of the Numeric Sizing Treatment Standards in Table 3. Treatment efficiencies can also be realized by locating treatment controls strategically within a drainage basin without being limited by the project boundary.

Where

C = runoff coefficient

i = watershed imperviousness ratio which is equal to the percent total imperviousness divided by 100

P_o = Maximized Detention Volume, in watershed inches

a = regression constant, a=1.582 and a=1.963 for 24 and 48 hour draw down, respectively

P_6 = mean annual runoff-producing rainfall depths, in watershed inches, Table #-1. See Appendix D.

The Urban Runoff Quality Management Approach is simple to apply. The following steps describe the use of the approach.

1. Identify the "BMP Drainage Area" that drains to the proposed BMP. This includes all areas that will contribute runoff to the proposed BMP, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP.
2. Calculate the "Watershed Imperviousness Ratio" (i), which is equal to the percent of total impervious area in the "BMP Drainage Area" divided by 100.
3. Calculate the "Runoff Coefficient" (C) using the following equation:

   $$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$$

4. Determine the "Mean Annual Runoff" (P6) for the "BMP Drainage Area" using Table #-1 in Appendix D.
5. Determine the "Regression Constant" (a) for the desired BMP drain down time. Use a=1.582 for 24 hrs and a=1.963 for 48 hr draw down.
6. Calculate the "Maximized Detention Volume" (Po) using the following equation:

   $$P_o = (a \bullet C) \bullet P_6$$

7. Calculate the required capture volume of the BMP by multiplying the "BMP Drainage Area" from Step 1 by the "Maximized Detention Volume" from Step 6 to give the BMP volume. Due to the mixed units that result (e.g., ac-in., ac-ft) it is recommended that the resulting volume be converted to ft^3 for use during design.

5.5.2 Flow-Based BMP Design

Flow-based BMP design standards apply to BMPs whose primary mode of pollutant removal depends on the rate of flow of runoff through the BMP. Examples of BMPs in this category include swales, sand filters, screening devices, and many proprietary products. Typically, a flow-based BMP design criteria calls for the capture and infiltration or treatment of the flow runoff produced by rain events of a specified magnitude.

The following are examples of flow-based BMP design standards from current municipal stormwater permits. The permits require that flow-based BMPs be designed to capture and then to infiltrate or treat stormwater runoff equal to one of the following:

- 10% of the 50-yr peak flow rate (Factored Flood Flow Approach)
- The flow of runoff produced by a rain event equal to at least two times the 85th percentile hourly rainfall intensity for the applicable area, based on historical records of hourly rainfall depths (California Stormwater BMP Handbook Approach)
- The flow of runoff resulting from a rain event equal to at least 0.2 in/hr intensity (Uniform Intensity Approach)

The reader is referred to the municipal stormwater program manager for the jurisdiction processing the new development or redevelopment project application to determine the specific requirements applicable to a proposed project.

The three typical requirements shown above all have in common a rainfall intensity element. That is, each criteria is based treating a flow of runoff produced by a rain event of specified rainfall intensity.

In the first example, the Factored Flood Flow Approach, the design rainfall intensity is a function of the location and time of concentration of the area discharging to the BMP. The intensity in this case is determined using Intensity-Duration-Frequency curves published by the flood control agency with jurisdiction over the project or available from climatic data centers. This approach is simple to apply when the 50-yr peak flow has already been determined for either drainage system design or flood control calculations.

In the second example, the California Stormwater BMP Handbook Approach (so called because it is recommended in this handbook), the rainfall intensity is a function of the location of the area discharging to the BMP. The intensity in this case can be determined using the rain intensity cumulative frequency curves developed for this Handbook based on analysis of long-term hourly rainfall data at numerous sites throughout California, with sites selected throughout the state representing a wide range of municipal stormwater permit areas, climatic areas, geography, and topography. These rain intensity cumulative frequency curves are included in Appendix D. This approach is recommended as it reflects local conditions throughout the state. The flow-based design criteria in some municipal permits require design based on two times the 85^{th} percentile hourly rainfall intensity. The factor of two included in these permits appears to be provided as a factor of safety: therefore, caution should be exercised when applying additional factors of safety during the design process so that over design can be avoided.

CHAPTER 5.7

Vegetated Swale TC-30

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	●
☑	Metals	▲
☑	Bacteria	●
☑	Oil and Grease	▲
☑	Organics	▲

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

CASQA

- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Vegetated Swale TC-30

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

Table 1 Grassed swale pollutant removal efficiency data

Study	TSS	TP	TN	NO_3	Metals	Bacteria	Type
	Removal Efficiencies (% Removal)						
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.
- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.
- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.
- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.
- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately $0.25 per ft^2. This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately $0.50 per ft^2, which compares favorably with other stormwater management practices.

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b].........	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c].........	Acre	0.25	$3,800	$5,200	$6,800	$950	$1,300	$1,650
General Excavation[d].........	Yd³	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e].........	Yd²	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil Seed, and Mulch[f]..	Yd²	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Sod[g].........	Yd²	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Subtotal	--	--	--	--	--	$5,116	$9,388	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	--	--	--	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = (top width + $\frac{8(\text{swale depth}^2)}{3(\text{top width})}$) x swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Vegetated Swale

Table 3 Estimated Maintenance Costs (SEWRPC, 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	\$0.85 / 1,000 ft²/ mowing	\$0.14 / linear foot	\$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	\$9.00 / 1,000 ft²/ year	\$0.18 / linear foot	\$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	\$0.10 / linear foot / year	\$0.10 / linear foot	\$0.10 / linear foot	–
Grass Reseeding with Mulch and Fertilizer	\$0.30 / yd²	\$0.01 / linear foot	\$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	\$0.15 / linear foot / year, plus \$25 / inspection	\$0.15 / linear foot	\$0.15 / linear foot	Inspect four times per year
Total	--	\$0.58 / linear foot	\$ 0.75 / linear foot	–

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

References and Sources of Additional Information

Barrett, Michael E., Walsh, Patrick M., Malina, Joseph F., Jr., Charbeneau, Randall J, 1998, "Performance of vegetative controls for treating highway runoff," *ASCE Journal of Environmental Engineering*, Vol. 124, No. 11, pp. 1121-1128.

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region.* Prepared for the Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD.

Center for Watershed Protection (CWP). 1996. *Design of Stormwater Filtering Systems.* Prepared for the Chesapeake Research Consortium, Solomons, MD, and USEPA Region V, Chicago, IL, by the Center for Watershed Protection, Ellicott City, MD.

Colwell, Shanti R., Horner, Richard R., and Booth, Derek B., 2000. *Characterization of Performance Predictors and Evaluation of Mowing Practices in Biofiltration Swales.* Report to King County Land And Water Resources Division and others by Center for Urban Water Resources Management, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA

Dorman, M.E., J. Hartigan, R.F. Steg, and T. Quasebarth. 1989. *Retention, Detention and Overland Flow for Pollutant Removal From Highway Stormwater Runoff. Vol. 1.* FHWA/RD 89/202. Federal Highway Administration, Washington, DC.

Goldberg. 1993. *Dayton Avenue Swale Biofiltration Study.* Seattle Engineering Department, Seattle, WA.

Harper, H. 1988. *Effects of Stormwater Management Systems on Groundwater Quality.* Prepared for Florida Department of Environmental Regulation, Tallahassee, FL, by Environmental Research and Design, Inc., Orlando, FL.

Kercher, W.C., J.C. Landon, and R. Massarelli. 1983. Grassy swales prove cost-effective for water pollution control. *Public Works*, 16: 53–55.

Koon, J. 1995. *Evaluation of Water Quality Ponds and Swales in the Issaquah/East Lake Sammamish Basins.* King County Surface Water Management, Seattle, WA, and Washington Department of Ecology, Olympia, WA.

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.Oakland, P.H. 1983. An evaluation of stormwater pollutant removal through grassed swale treatment. In *Proceedings of the International Symposium of Urban Hydrology, Hydraulics and Sediment Control, Lexington, KY.* pp. 173–182.

Occoquan Watershed Monitoring Laboratory. 1983. Final Report: *Metropolitan Washington Urban Runoff Project*. Prepared for the Metropolitan Washington Council of Governments, Washington, DC, by the Occoquan Watershed Monitoring Laboratory, Manassas, VA.

Pitt, R., and J. McLean. 1986. *Toronto Area Watershed Management Strategy Study: Humber River Pilot Watershed Project*. Ontario Ministry of Environment, Toronto, ON.

Schueler, T. 1997. Comparative Pollutant Removal Capability of Urban BMPs: A reanalysis. *Watershed Protection Techniques* 2(2):379–383.

Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance: Recommendations and Design Considerations*. Publication No. 657. Water Pollution Control Department, Seattle, WA.

Southeastern Wisconsin Regional Planning Commission (SWRPC). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Technical report no. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

U.S. EPA, 1999, Stormwater Fact Sheet: Vegetated Swales, Report # 832-F-99-006 http://www.epa.gov/owm/mtb/vegswale.pdf, Office of Water, Washington DC.

Wang, T., D. Spyridakis, B. Mar, and R. Horner. 1981. *Transport, Deposition and Control of Heavy Metals in Highway Runoff.* FHWA-WA-RD-39-10. University of Washington, Department of Civil Engineering, Seattle, WA.

Washington State Department of Transportation, 1995, *Highway Runoff Manual*, Washington State Department of Transportation, Olympia, Washington.

Welborn, C., and J. Veenhuis. 1987. *Effects of Runoff Controls on the Quantity and Quality of Urban Runoff in Two Locations in Austin, TX.* USGS Water Resources Investigations Report No. 87-4004. U.S. Geological Survey, Reston, VA.

Yousef, Y., M. Wanielista, H. Harper, D. Pearce, and R. Tolbert. 1985. *Best Management Practices: Removal of Highway Contaminants By Roadside Swales*. University of Central Florida and Florida Department of Transportation, Orlando, FL.

Yu, S., S. Barnes, and V. Gerde. 1993. *Testing of Best Management Practices for Controlling Highway Runoff.* FHWA/VA-93-R16. Virginia Transportation Research Council, Charlottesville, VA.

Information Resources

Maryland Department of the Environment (MDE). 2000. *Maryland Stormwater Design Manual*. www.mde.state.md.us/environment/wma/stormwatermanual. Accessed May 22, 2001.

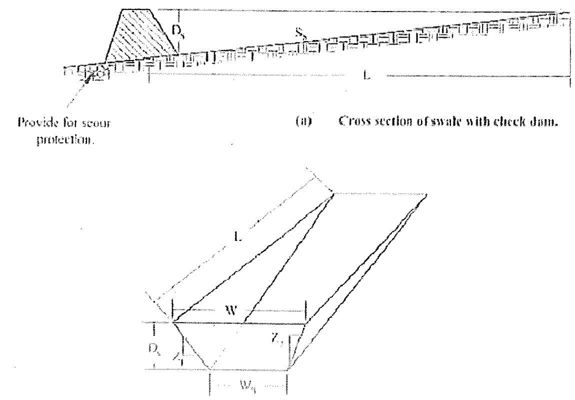
Reeves, E. 1994. Performance and Condition of Biofilters in the Pacific Northwest. *Watershed Protection Techniques* 1(3):117–119.

Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance.* Recommendations and Design Considerations. Publication No. 657. Seattle Metro and Washington Department of Ecology, Olympia, WA.

USEPA 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.* EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water. Washington, DC.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems.* Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC, by the Watershed Management Institute, Ingleside, MD.

Vegetated Swale TC-30



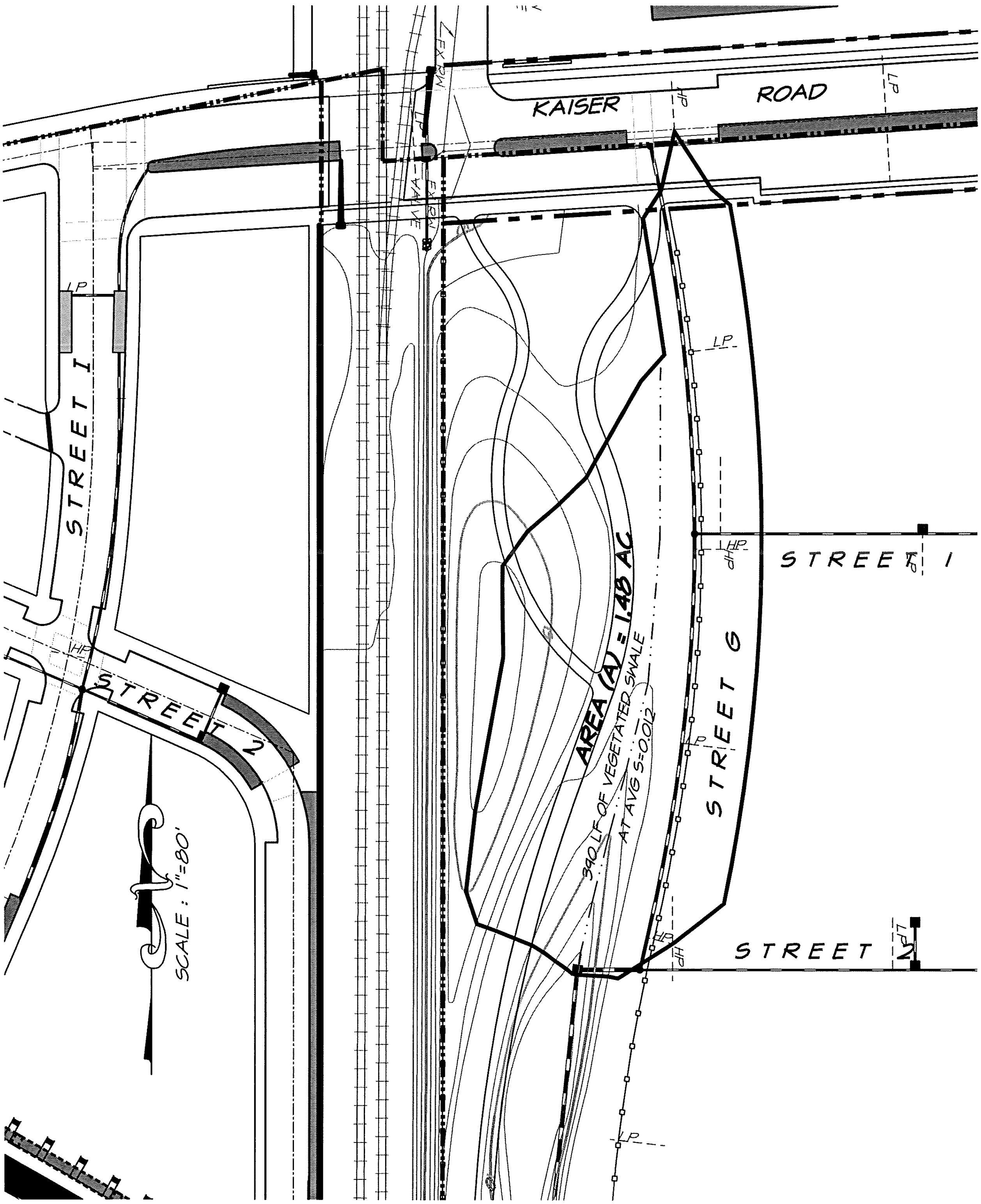
(a) Cross section of swale with check dam.

(b) Dimensional view of swale impoundment area.

Notation:

- L = Length of swale impoundment area per check dam (ft)
- D_s = Depth of check dam (ft)
- S_s = Bottom slpe of swale (ft/ft)
- W = Top width of check dam (ft)
- W_B = Bottom width of check dam (ft)
- $Z_{(1\&2)}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

BMP Exhibit & Calculation



PROPOSED BMP EXHIBIT FOR
VEGETATED SWALE BMP CALCULATION

BMP Design Flow Calculation

Q = (0.20) x (C) x (A) x (K) ←— RATIONAL METHOD

WHERE : 0.20 in/hr IS THE RAINFALL INTENSITY THAT OCCURS DURING THE 85th PERCENTILE MEAN ANNUAL 24-HOUR STORM EVENT
Q = DESIGN FLOW RATE
C = 0.80 (SEE ATTACHED)
A = 1.48 AC (SEE ATTACHED)
K = 0.77 (SEE ATTACHED)

Q = (0.20) x (0.80) x (1.48) x (0.77)
= **0.1823 cfs**

Channel Calculator (using MANNING'S EQUATION)

Given Input Data:

- Shape .... Trapezoidal
- Solving for .... Depth of Flow
- Flowrate .... 0.1823 cfs
- Slope .... 0.0120 ft/ft
- Manning's n 0.2500
- Height .... 18.0000 in
- Bottom width .... 24.0000 in
- Left slope .... 0.3333 ft/ft (V/H)
- Right slope .... 0.3333 ft/ft (V/H)

Computed Results:

- Depth .... 3.3486 in < 4 in, OK!
- Velocity .... 0.2303 fps
- Full Flowrate .... 5.6917 cfs
- Flow area 0.7917 ft2
- Flow perimeter .... 45.1803 in
- Hydraulic radius .... 2.5234 in
- Top width .... 44.0936 in
- Area 9.7507 ft2
- Perimeter .... 137.8522 in
- Percent full .... 18.6033 %

HRT = (L ft/V fps) x (1 min/60 sec) ←— HYDRAULIC RESIDENCE TIME

$$HRT = \frac{390 \text{ ft}}{0.2303 \text{ ft/sec}} \times \frac{1 \text{ min}}{60 \text{ sec}} = 27.2 \text{ min} > 10 \text{ min}, \text{ OK !}$$

Appendix C

Cisterns / Rain Barrels

Reference Exhibit

Contra Costa County Stormwater C.3 Guidebook, 2006 (or approved equal)

THESE FACT SHEETS WERE TAKEN FROM THE CONTRA COSTA STORMWATER C.3 GUIDELINE, APPROVED EQUAL BY NAPA COUNTY PUBLIC WORKS CAN BE USED

Downspouts and Cisterns

Construction Innovation Forum

Better Homes & Gardens

Drainage from roofs can be directed to pervious areas and allowed to infiltrate into the soil. No further treatment or detention is required if the ratio of impervious to pervious area does not exceed 2:1 for treatment only, 1:1 for flow control plus treatment. "Self-retaining" pervious areas must be graded and designed to retain at least 1" rainfall over the entire area, as described in the fact sheet for grading, paving, and landscaping.

Splash blocks, swales, or pipes direct downspout discharge away from foundations to lawns or planting beds. Shallow depressions, or "rain gardens," may collect and detain runoff.

Cisterns or rain barrels can capture and detain a portion of the runoff and allow it to seep away slowly. These devices may have a valve to control when and how fast they empty. Cisterns can also expand the effective capacity of dry wells, infiltration trenches, and other infiltration practices.

Design and Construction. Cisterns or rain barrels can be fashioned from a variety of materials. Cisterns capable of retaining water for more than 72 hours must be sealed against entry by mosquitoes, which can enter openings as small as 1/16".

Maintenance. Maintenance consists of inspecting cisterns and piping and removing any accumulated sediment.

Best Uses

- Landscaped areas near buildings

Advantages

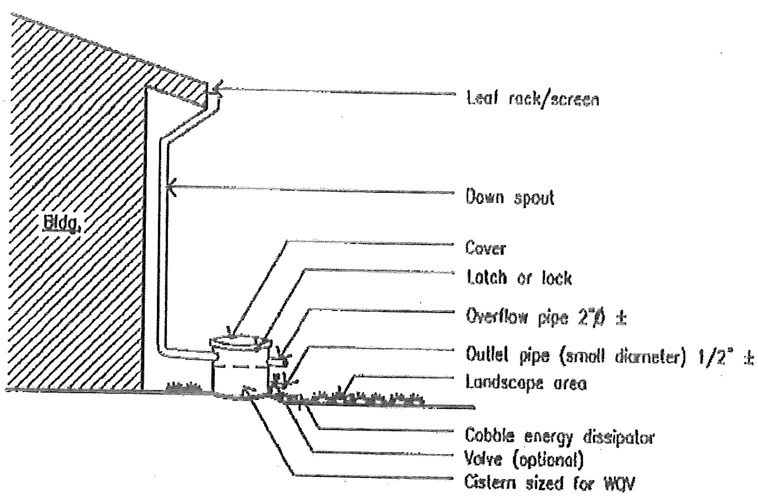
- Low-cost
- Versatile
- Conserves water
- Low maintenance

Limitations

- Soils receiving runoff must be adequately drained.
- Foundations should be protected from excessive moisture in expansive clay soils.
- Impervious-to-pervious ratio should not exceed 2:1 for treatment only, 1:1 for flow control and treatment.
- Bay Area seasonal rainfall patterns make water storage somewhat less attractive.

Design Checklist for Downspouts and Cisterns

- ☐ Discharge is directed away from foundations.
- ☐ Receiving landscaped area is at least ½ tributary impervious (roof) area (1:1 ratio applies if flow-control is required).
- ☐ Receiving landscaped area is designed to retain runoff (see Grading, Paving, and Landscaping Fact Sheet).
- ☐ Slopes do not exceed 4% (unless terraced).
- ☐ Cistern valve or orifice designed to allow slow drainage.
- ☐ Cistern designed to drain completely within 72 hours or are tightly sealed against mosquito entry.
- ☐ Cistern overflow is directed to avoid damage.
- ☐ Cistern is designed to protect against access by small children (secure or less than 4" diameter top opening).



Bay Area Stormwater Management Agencies Association, *Start at the Source* (1999)

Appendix D

Green Roofs

Reference Exhibit

Contra Costa County Stormwater C.3
Guidebook, 2006 (or approved equal)

THIS FACT SHEET WAS TAKEN FROM THE CONTRA COSTA STORMWATER C.3 GUIDELINE, APPROVED EQUAL BY NAPA COUNTY PUBLIC WORKS CAN BE USED.

Green Roofs

Gap Headquarters, San Bruno (*William McDonough & Partners*)

Green roofs can be either *extensive*, with a 3"-7" lightweight substrate and a few types of low-profile, low-maintenance plants, or *intensive* with a thicker (8" to 48") substrate, more varied plantings, and a more garden-like appearance.

The extensive installation pictured above, at Gap Headquarters in San Bruno, has experienced relatively few problems after nearly a decade in use.

Design and Construction. Extensive green roof systems contain several layers of protective materials to convey water away from the roof deck. Starting from the bottom up, a waterproof membrane is installed, followed by a root barrier, a layer of insulation (optional), a drainage layer, a filter fabric for fine soils, the engineered growing medium or soil substrate, and the plant material.

Design and installation is typically by an established vendor.

Maintenance. Installations require inspection at least semiannually and may or may not require irrigation in the Bay Area semi-arid climate.

Agilent Headquarters, Santa Clara (*Agilent*)

See www.greenroofs.com for information about and more examples of green roofs.

Best Uses

- New buildings with innovative architecture
- Urban centers

Advantages

- Minimize roof runoff
- Reduce "heat island" effect
- Absorb sound
- Provide bird habitat
- Structural requirements similar to other roofing options (for extensive green roofs).
- Maintenance costs similar to other roofing options

Limitations

- Sloped roofs require steps or cross-battens
- Non-traditional design

CONTRA COSTA CLEAN WATER PROGRAM

Integrated Management Practices Fact Sheets

Appendix E

Pervious Pavement

Reference Exhibit

California Stormwater Quality Association (CASQA)

Pervious Pavements SD-20

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Pervious paving is used for light vehicle loading in parking areas. The term describes a system comprising a load-bearing, durable surface together with an underlying layered structure that temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface can itself be porous such that water infiltrates across the entire surface of the material (e.g., grass and gravel surfaces, porous concrete and porous asphalt), or can be built up of impermeable blocks separated by spaces and joints, through which the water can drain. This latter system is termed 'permeable' paving. Advantages of pervious pavements is that they reduce runoff volume while providing treatment, and are unobtrusive resulting in a high level of acceptability.

Approach

Attenuation of flow is provided by the storage within the underlying structure or sub base, together with appropriate flow controls. An underlying geotextile may permit groundwater recharge, thus contributing to the restoration of the natural water cycle. Alternatively, where infiltration is inappropriate (e.g., if the groundwater vulnerability is high, or the soil type is unsuitable), the surface can be constructed above an impermeable membrane. The system offers a valuable solution for drainage of spatially constrained urban areas.

Significant attenuation and improvement in water quality can be achieved by permeable pavements, whichever method is used. The surface and subsurface infrastructure can remove both the soluble and fine particulate pollutants that occur within urban runoff. Roof water can be piped into the storage area directly, adding areas from which the flow can be attenuated. Also, within lined systems, there is the opportunity for stored runoff to be piped out for reuse.

Suitable Applications

Residential, commercial and industrial applications are possible. The use of permeable pavement may be restricted in cold regions, arid regions or regions with high wind erosion. There are some specific disadvantages associated with permeable pavement, which are as follows:

CASQA

- Permeable pavement can become clogged if improperly installed or maintained. However, this is countered by the ease with which small areas of paving can be cleaned or replaced when blocked or damaged.
- Their application should be limited to highways with low traffic volumes, axle loads and speeds (less than 30 mph limit), car parking areas and other lightly trafficked or non-trafficked areas. Permeable surfaces are currently not considered suitable for adoptable roads due to the risks associated with failure on high speed roads, the safety implications of ponding, and disruption arising from reconstruction.
- When using un-lined, infiltration systems, there is some risk of contaminating groundwater, depending on soil conditions and aquifer susceptibility. However, this risk is likely to be small because the areas drained tend to have inherently low pollutant loadings.
- The use of permeable pavement is restricted to gentle slopes.
- Porous block paving has a higher risk of abrasion and damage than solid blocks.

Design Considerations

Designing New Installations

If the grades, subsoils, drainage characteristics, and groundwater conditions are suitable, permeable paving may be substituted for conventional pavement on parking areas, cul de sacs and other areas with light traffic. Slopes should be flat or very gentle. Scottish experience has shown that permeable paving systems can be installed in a wide range of ground conditions, and the flow attenuation performance is excellent even when the systems are lined.

The suitability of a pervious system at a particular pavement site will, however, depend on the loading criteria required of the pavement.

Where the system is to be used for infiltrating drainage waters into the ground, the vulnerability of local groundwater sources to pollution from the site should be low, and the seasonal high water table should be at least 4 feet below the surface.

Ideally, the pervious surface should be horizontal in order to intercept local rainfall at source. On sloping sites, pervious surfaces may be terraced to accommodate differences in levels.

Design Guidelines

The design of each layer of the pavement must be determined by the likely traffic loadings and their required operational life. To provide satisfactory performance, the following criteria should be considered:

- The subgrade should be able to sustain traffic loading without excessive deformation.
- The granular capping and sub-base layers should give sufficient load-bearing to provide an adequate construction platform and base for the overlying pavement layers.
- The pavement materials should not crack of suffer excessive rutting under the influence of traffic. This is controlled by the horizontal tensile stress at the base of these layers.

Pervious Pavements SD-20

There is no current structural design method specifically for pervious pavements. Allowances should be considered the following factors in the design and specification of materials:

- Pervious pavements use materials with high permeability and void space. All the current UK pavement design methods are based on the use of conventional materials that are dense and relatively impermeable. The stiffness of the materials must therefore be assessed.
- Water is present within the construction and can soften and weaken materials, and this must be allowed for.
- Existing design methods assume full friction between layers. Any geotextiles or geomembranes must be carefully specified to minimize loss of friction between layers.
- Porous asphalt loses adhesion and becomes brittle as air passes through the voids. Its durability is therefore lower than conventional materials.

The single sized grading of materials used means that care should be taken to ensure that loss of finer particles between unbound layers does not occur.

Positioning a geotextile near the surface of the pervious construction should enable pollutants to be trapped and retained close to the surface of the construction. This has both advantages and disadvantages. The main disadvantage is that the filtering of sediments and their associated pollutants at this level may hamper percolation of waters and can eventually lead to surface ponding. One advantage is that even if eventual maintenance is required to reinstate infiltration, only a limited amount of the construction needs to be disturbed, since the sub-base below the geotextile is protected. In addition, the pollutant concentration at a high level in the structure allows for its release over time. It is slowly transported in the stormwater to lower levels where chemical and biological processes may be operating to retain or degrade pollutants.

The design should ensure that sufficient void space exists for the storage of sediments to limit the period between remedial works.

- Pervious pavements require a single size grading to give open voids. The choice of materials is therefore a compromise between stiffness, permeability and storage capacity.
- Because the sub-base and capping will be in contact with water for a large part of the time, the strength and durability of the aggregate particles when saturated and subjected to wetting and drying should be assessed.
- A uniformly graded single size material cannot be compacted and is liable to move when construction traffic passes over it. This effect can be reduced by the use of angular crushed rock material with a high surface friction.

In pollution control terms, these layers represent the site of long term chemical and biological pollutant retention and degradation processes. The construction materials should be selected, in addition to their structural strength properties, for their ability to sustain such processes. In general, this means that materials should create neutral or slightly alkaline conditions and they should provide favorable sites for colonization by microbial populations.

Construction/Inspection Considerations

- Permeable surfaces can be laid without cross-falls or longitudinal gradients.
- The blocks should be lain level
- They should not be used for storage of site materials, unless the surface is well protected from deposition of silt and other spillages.
- The pavement should be constructed in a single operation, as one of the last items to be built, on a development site. Landscape development should be completed before pavement construction to avoid contamination by silt or soil from this source.
- Surfaces draining to the pavement should be stabilized before construction of the pavement.
- Inappropriate construction equipment should be kept away from the pavement to prevent damage to the surface, sub-base or sub-grade.

Maintenance Requirements

The maintenance requirements of a pervious surface should be reviewed at the time of design and should be clearly specified. Maintenance is required to prevent clogging of the pervious surface. The factors to be considered when defining maintenance requirements must include:

- Type of use
- Ownership
- Level of trafficking
- The local environment and any contributing catchments

Studies in the UK have shown satisfactory operation of porous pavement systems without maintenance for over 10 years and recent work by Imbe et al. at 9th ICUD, Portland, 2002 describes systems operating for over 20 years without maintenance. However, performance under such regimes could not be guaranteed, Table 1 shows typical recommended maintenance regimes:

Pervious Pavements SD-20

Table 1 Typical Recommended Maintenance Regimes

Activity	Schedule
■ Minimize use of salt or grit for de-icing ■ Keep landscaped areas well maintained ■ Prevent soil being washed onto pavement	Ongoing
■ Vacuum clean surface using commercially available sweeping machines at the following times: - End of winter (April) - Mid-summer (July / August) - After Autumn leaf-fall (November)	2/3 x per year
■ Inspect outlets	Annual
■ If routine cleaning does not restore infiltration rates, then reconstruction of part of the whole of a pervious surface may be required. ■ The surface area affected by hydraulic failure should be lifted for inspection of the internal materials to identify the location and extent of the blockage. ■ Surface materials should be lifted and replaced after brush cleaning. Geotextiles may need complete replacement. ■ Sub-surface layers may need cleaning and replacing. ■ Removed silts may need to be disposed of as controlled waste.	As needed (infrequent) Maximum 15-20 years

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 1 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Cost Considerations

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 2 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

Pervious Pavements

Table 2 Engineer's Estimate for Porous Pavement

Porous Pavement														
Item	Units	Price	Cycles/ Year	Quant. 1 Acre WS	Total	Quant. 2 Acre WS	Total	Quant. 3 Acre WS	Total	Quant. 4 Acre WS	Total	Quant. 5 Acre WS	Total
Grading	SY	$2.00		604	$1,208	1209	$2,418	1812	$3,624	2419	$4,838	3020	$6,040
Paving	SY	$19.00		212	$4,028	424	$8,056	636	$12,084	848	$16,112	1060	$20,140
Excavation	CY	$3.60		201	$724	403	$1,451	604	$2,174	806	$2,902	1008	$3,629
Filter Fabric	SY	$1.15		700	$805	1400	$1,610	2000	$2,300	2800	$3,220	3600	$4,140
Stone Fill	CY	$16.00		201	$3,216	403	$6,448	604	$9,684	806	$12,896	1008	$16,128
Sand	CY	$7.00		100	$700	200	$1,400	300	$2,100	400	$2,800	500	$3,500
Sight Well	EA	$300.00		2	$600	3	$900	4	$1,200	7	$2,100	7	$2,100
Seeding	LF	$0.05		644	$32	1288	$64	1932	$97	2576	$129	3220	$161
Check Dam	CY	$35.00		0	$0	0	$0	0	$0	0	$0	0	$0
Total Construction Costs					$10,105		$19,929		$29,619		$40,158		$49,798
Construction Costs Amortized for 20 Years					$505		$996		$1,481		$2,008		$2,490

Annual Maintenance Expense														
Item	Units	Price	Cycles/ Year	Quant. 1 Acre WS	Total	Quant. 2 Acre WS	Total	Quant. 3 Acre WS	Total	Quant. 4 Acre WS	Total	Quant. 5 Acre WS	Total
Sweeping	AC	$250.00	6	1	$1,500	2	$3,000	3	$4,500	4	$6,000	5	$7,500
Washing	AC	$250.00	6	1	$1,500	2	$3,000	3	$4,500	4	$6,000	5	$7,500
Inspection	MH	$20.00	5	5	$100	5	$100	5	$100	5	$100	5	$100
Deep Clean	AC	$450.00	0.5	1	$225	2	$450	3	$675	3.9	$878	5	$1,125
Total Annual Maintenance Expense					$3,980		$7,792		$11,651		$15,483		$19,370

Other Resources

Abbott C.L. and Comino-Mateos L. 2001. *In situ performance monitoring of an infiltration drainage system and field testing of current design procedures.* Journal CIWEM, 15(3), pp.198-202.

Construction Industry Research and Information Association (CIRIA). 2002. *Source Control using Constructed Pervious Surfaces C582*, London, SW1P 3AU.

Construction Industry Research and Information Association (CIRIA). 2000. *Sustainable urban drainage systems - design manual for Scotland and Northern Ireland Report C521*, London, SW1P 3AU.

Construction Industry Research and Information Association (CIRIA). 2000 C522 *Sustainable urban drainage systems - design manual for England and Wales*, London, SW1P 3AU.

Construction Industry Research and Information Association (CIRIA). *RP448 Manual of good practice for the design, construction and maintenance of infiltration drainage systems for stormwater runoff control and disposal*, London, SW1P 3AU.

Dierkes C., Kuhlmann L., Kandasamy J. & Angelis G. Pollution Retention Capability and Maintenance of Permeable Pavements. *Proc 9th International Conference on Urban Drainage, Portland Oregon, September 2002.*

Hart P (2002) Permeable Paving as a Stormwater Source Control System. *Paper presented at Scottish Hydraulics Study Group 14th* Annual seminar, SUDS. 22 March 2002, Glasgow.

Kobayashi M., 1999. Stormwater runoff control in Nagoya City. Proc. 8 th Int. Conf. on

Urban Storm Drainage, Sydney, Australia, pp.825-833.

Landphair, H., McFalls, J., Thompson, D., 2000, Design Methods, Selection, and Cost Effectiveness of Stormwater Quality Structures, Texas Transportation Institute Research Report 1837-1, College Station, Texas.

Legret M, Colandini V, Effects of a porous pavement with reservior strucutre on runoff water:water quality and the fate of heavy metals. Laboratoire Central Des Ponts et Chaussesss

Macdonald K. & Jefferies C. Performance Comparison of Porous Paved and Traditional Car Parks. *Proc. First National Conference on Sustainable Drainage Systems, Coventry June 2001.*

Niemczynowicz J, Hogland W, 1987: Test of porous pavements performed in Lund, Sweden, in Topics in Drainage Hydraulics and Hydrology. BC. Yen (Ed.), pub. Int. Assoc. For Hydraulic Research, pp 19-80.

Pratt C.J. SUSTAINABLE URBAN DRAINAGE – A Review of published material on the performance of various SUDS devices prepared for the UK Environment Agency. Coventry University, UK December 2001.

Pratt C.J., 1995. Infiltration drainage – case studies of UK practice. Project Report

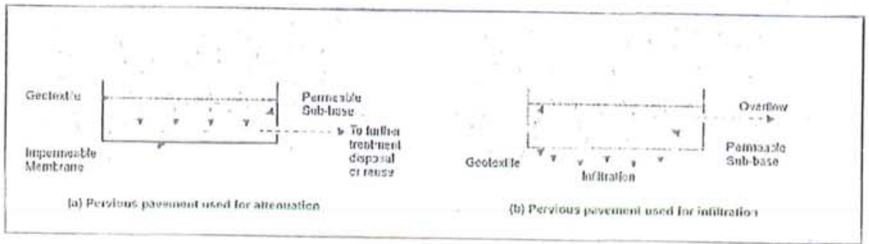
22,Construction Industry Research and Information Association, London, SW1P 3AU; also known as National Rivers Authority R & D Note 485

Pratt. C. J., 1990. Permeable Pavements for Stormwater Quality Enhancement. In: Urban Stormwater Quality Enhancement - Source Control, retrofitting and combined sewer technology, Ed. H.C. Torno, ASCE, ISBN 087262 7594, pp. 131-155

Raimbault G., 1997 French Developments in Reservoir Structures Sustainable water resources I the 21st century. Malmo Sweden

Schlüter W. & Jefferies C. Monitoring the outflow from a *Porous Car Park Proc. First National Conference on Sustainable Drainage Systems, Coventry June 2001*.

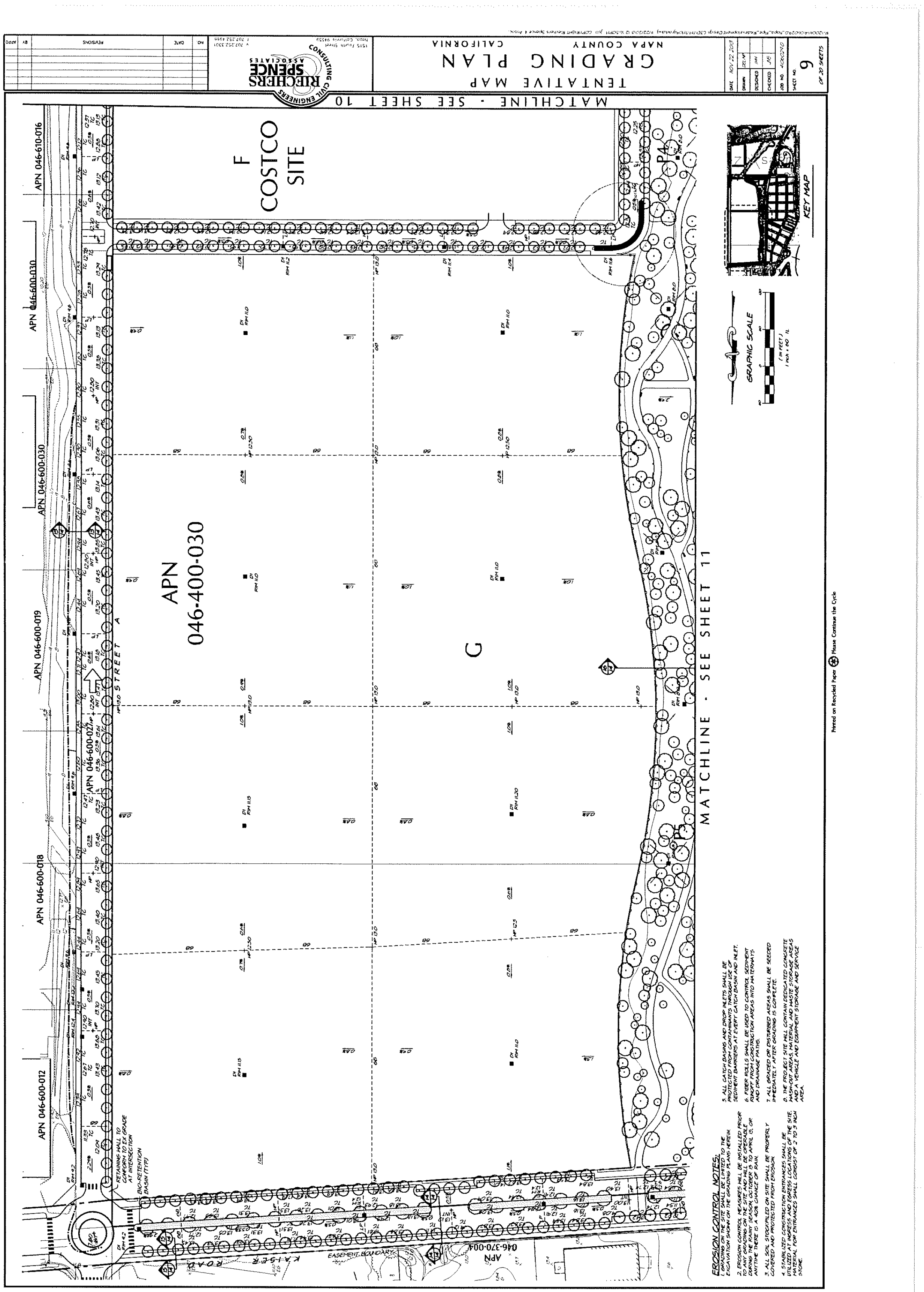
Wild, T.C., Jefferies, C., and D'Arcy, B.J. SUDS in Scotland – the Scottish SUDS database Report No SR(02)09 *Scotland and Northern Ireland Forum for Environmental Research, Edinburgh*. In preparation August 2002.



Schematics of a Pervious Pavement System

SECTION IX

GRADING AND UTILITY PLANS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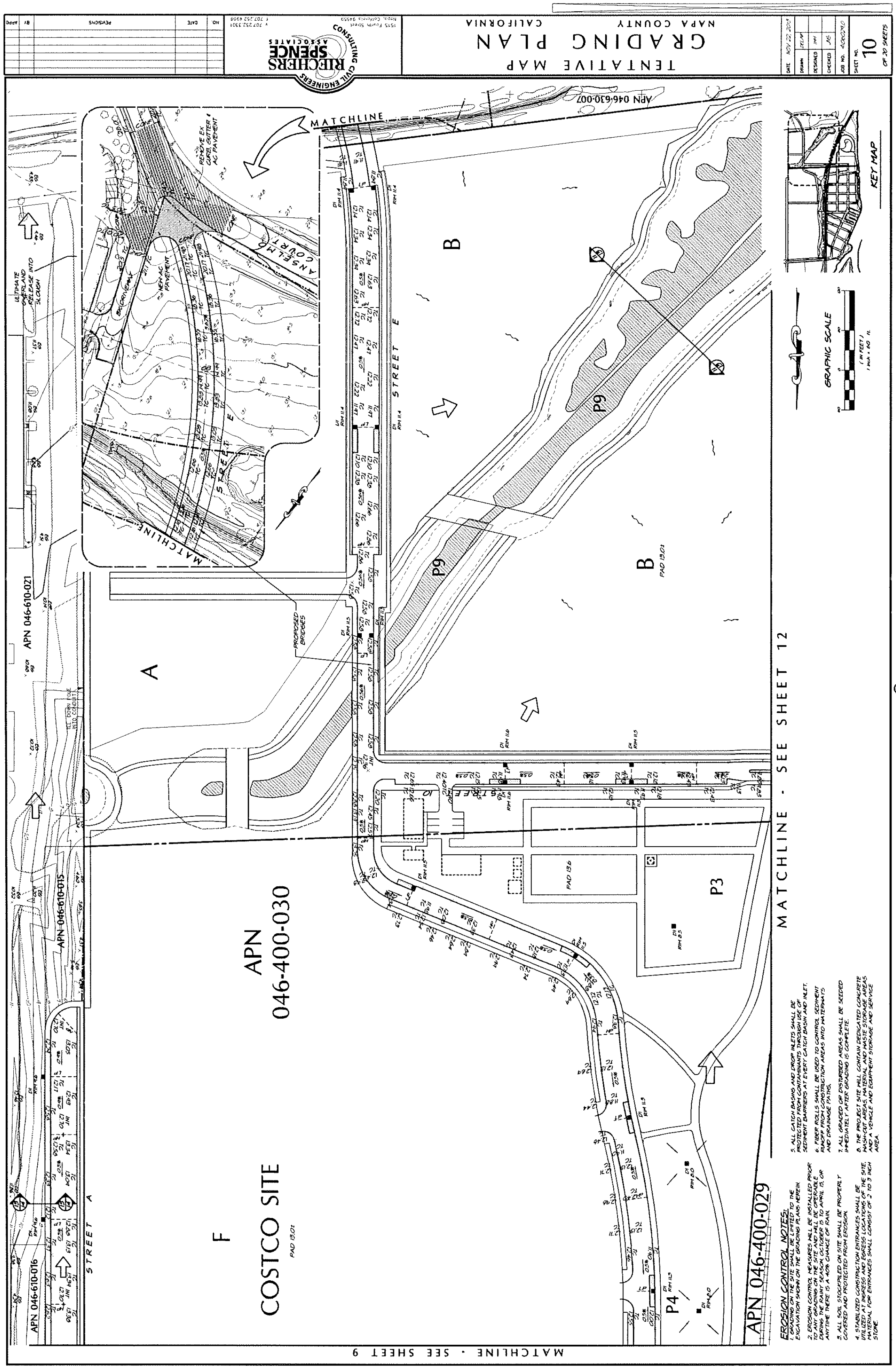
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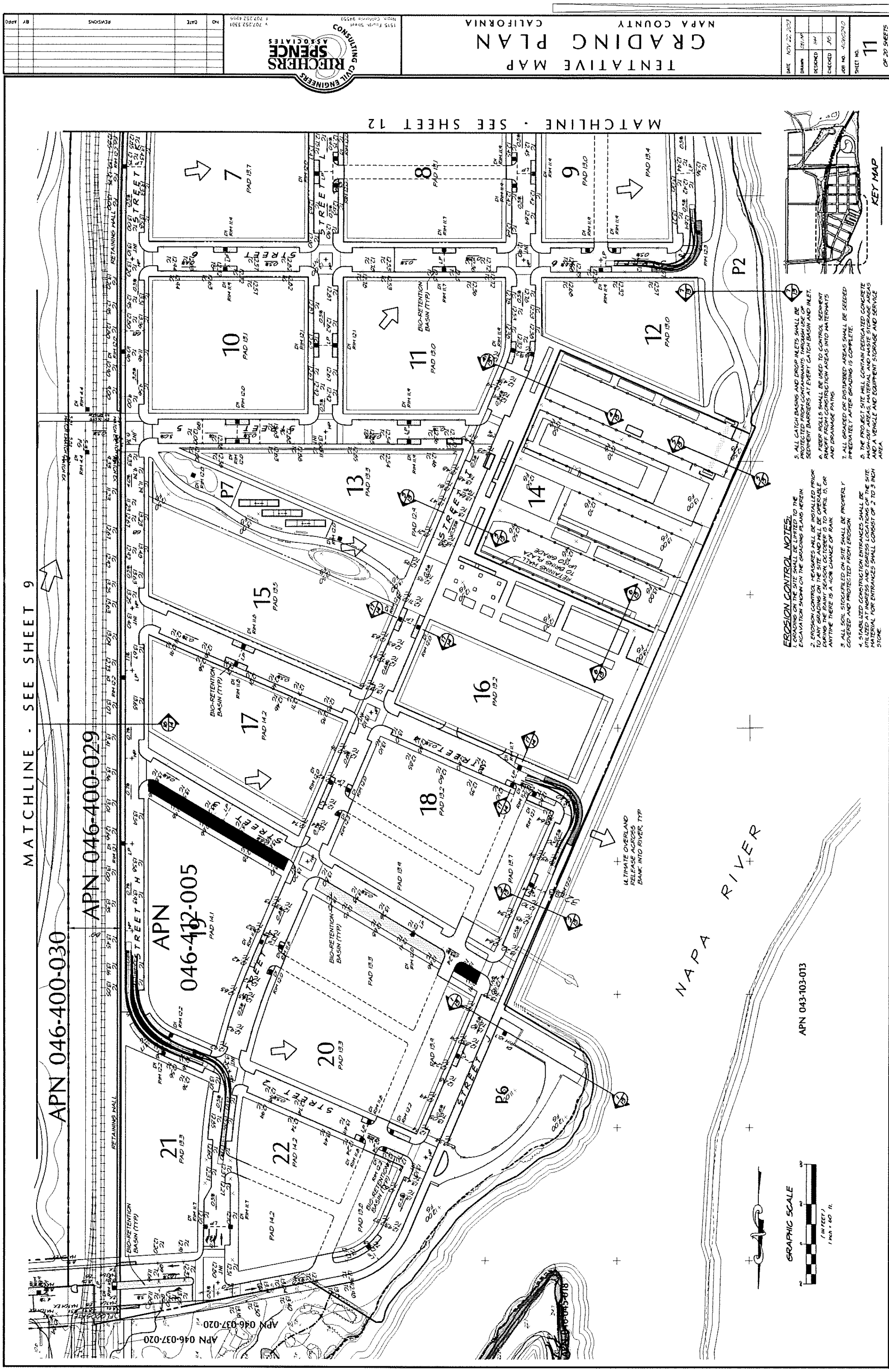
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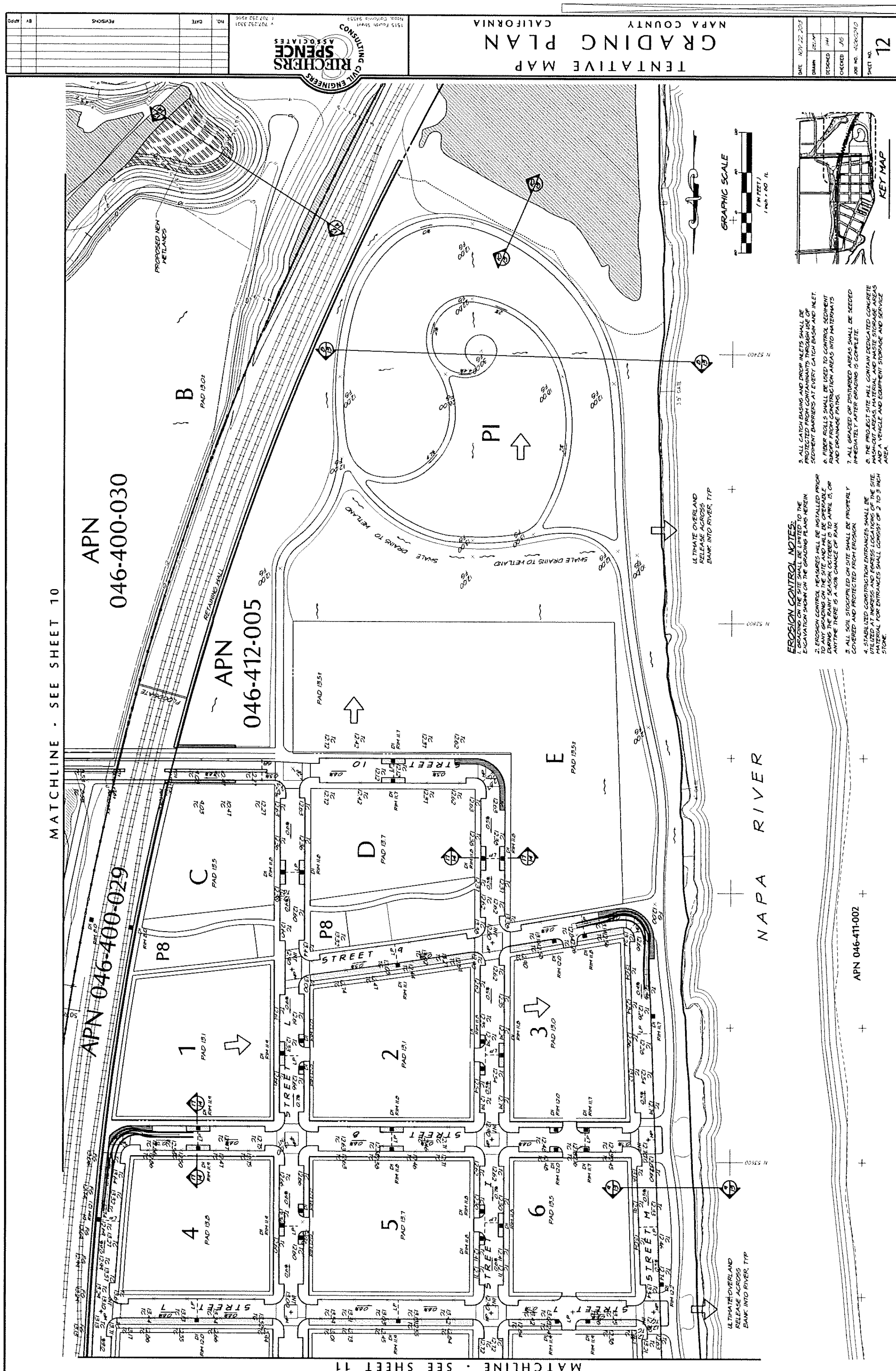
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NAPA RIVER
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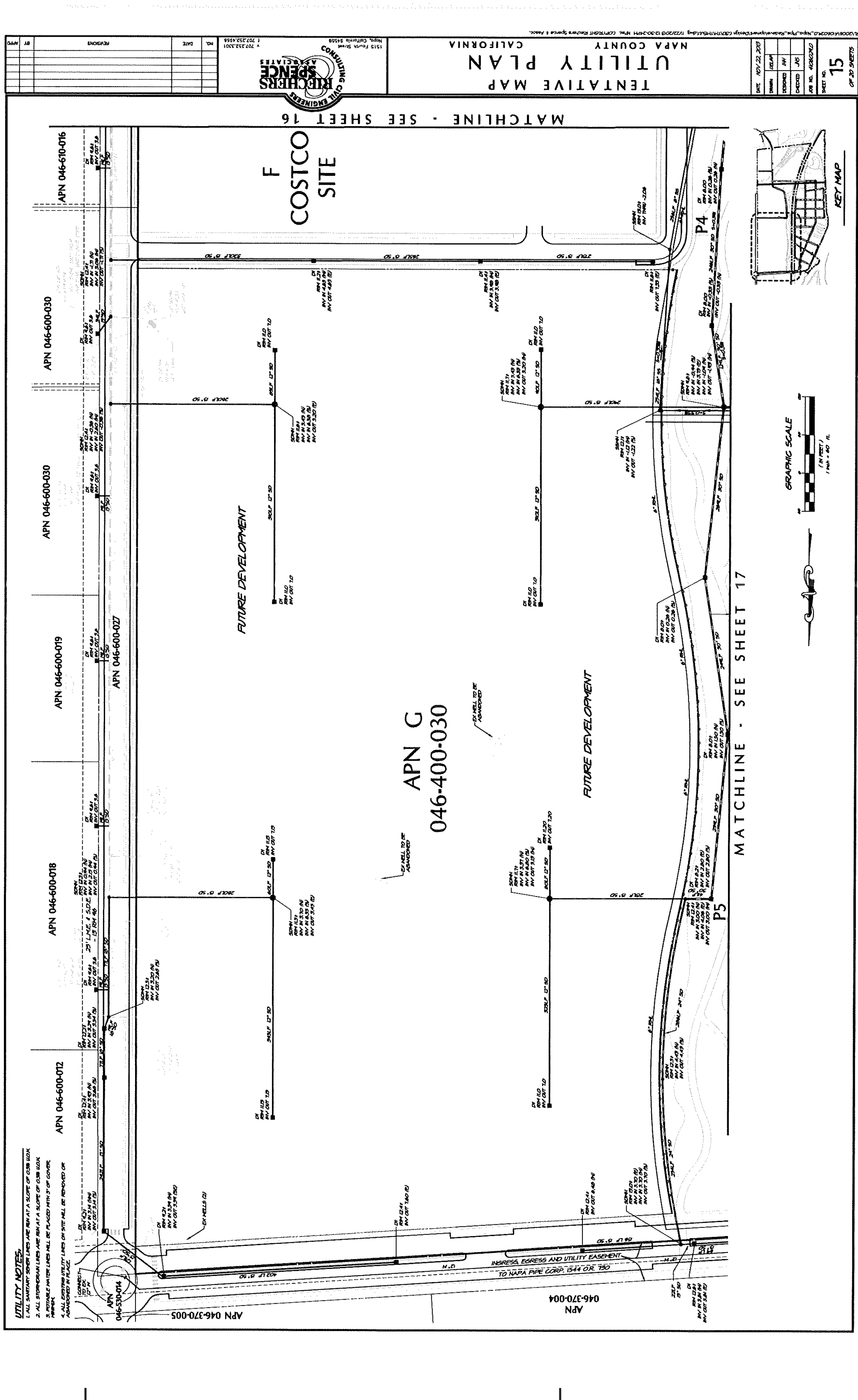
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KEY MAP
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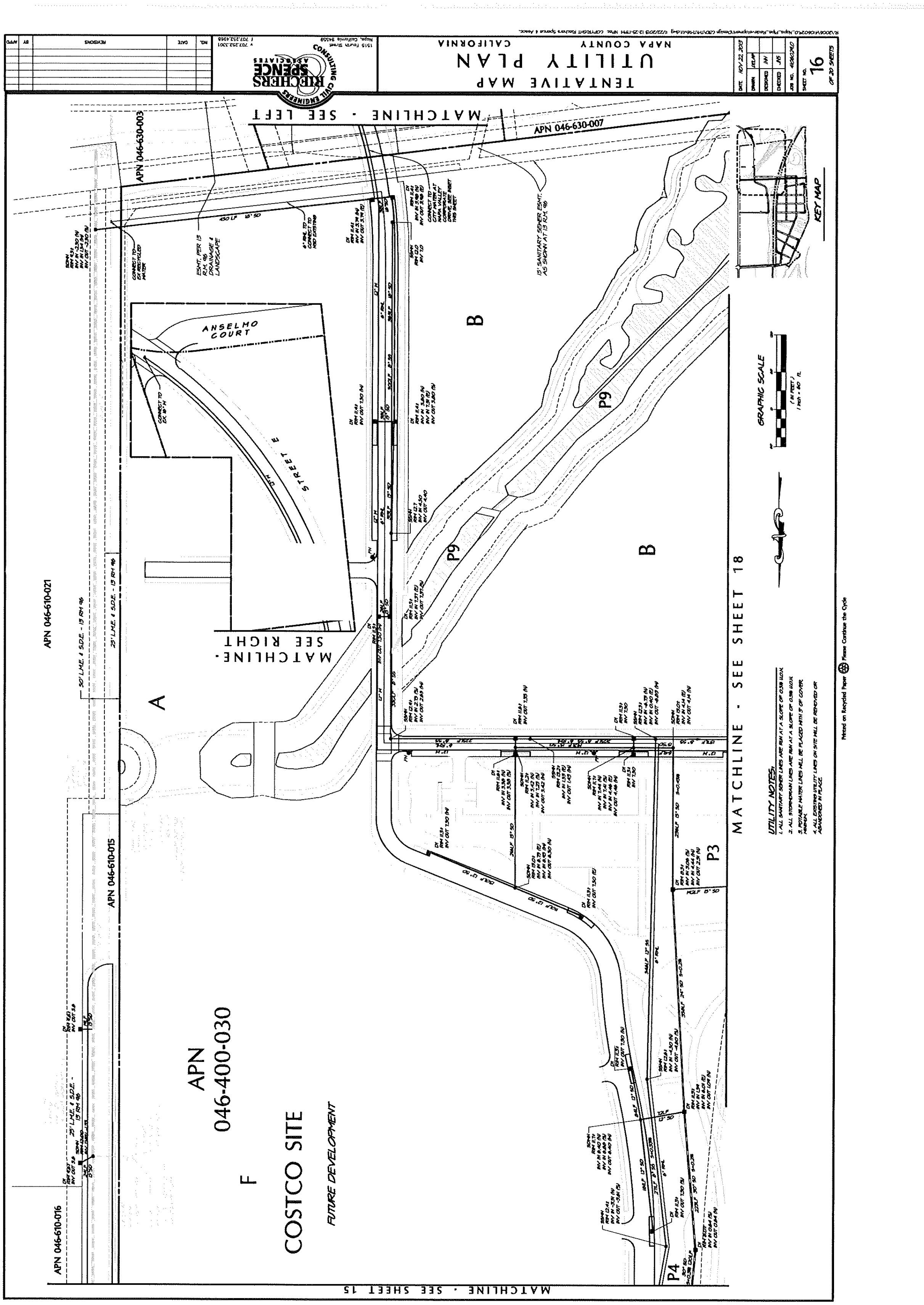
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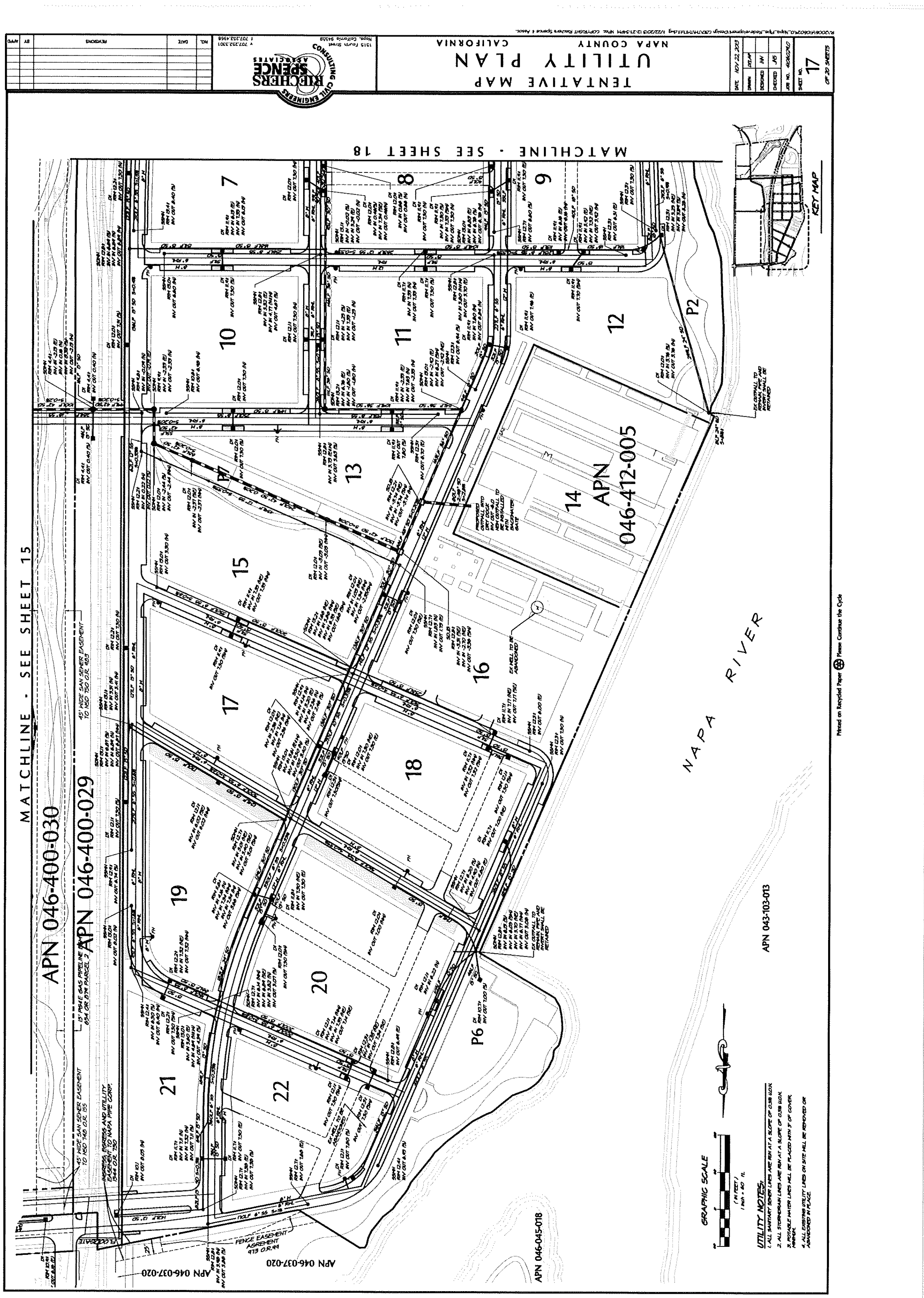
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KEY MAP
GRAPHIC SCALE
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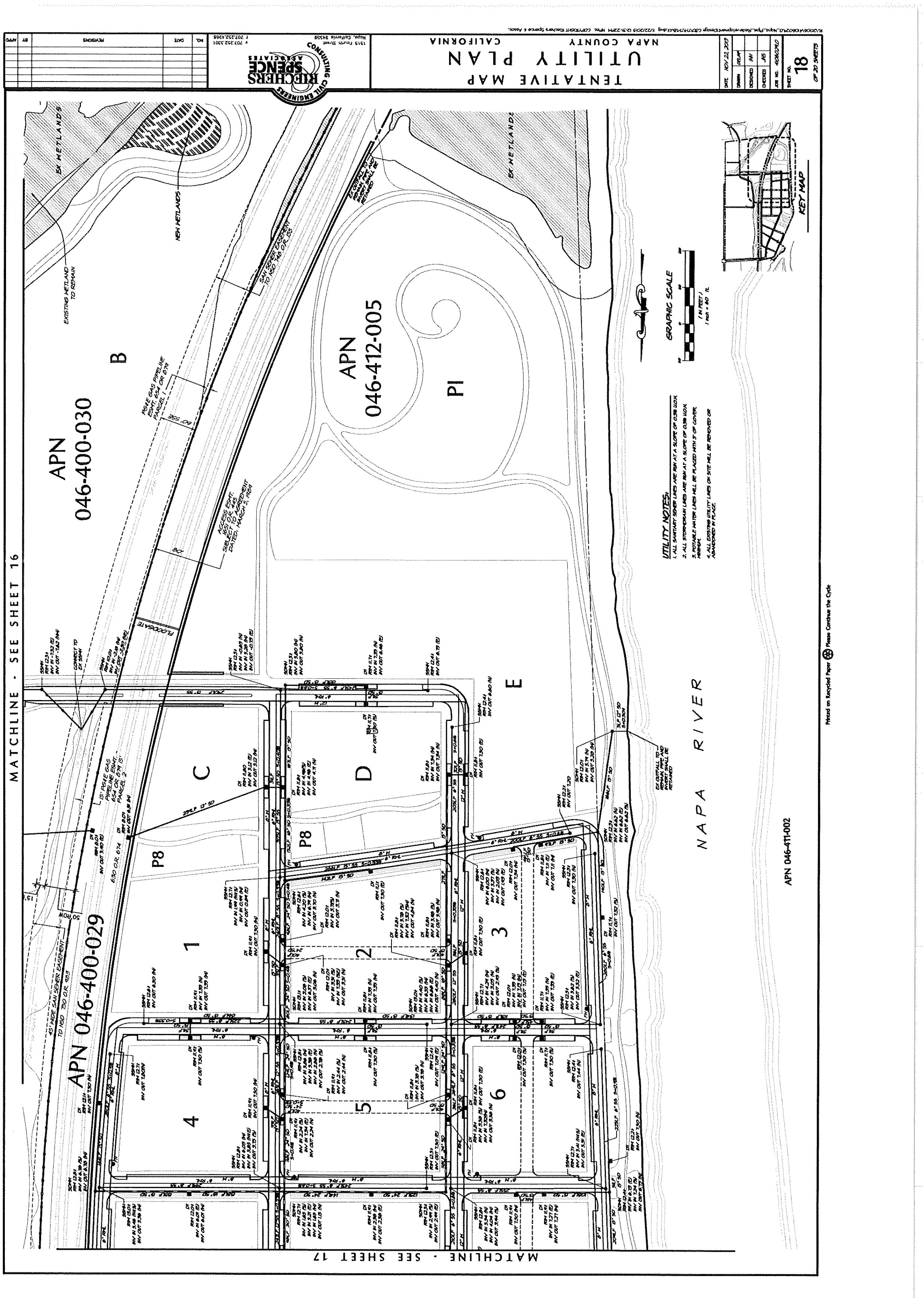
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NAPA RIVER
EX WETLANDS
NEW WETLANDS
UTILITY NOTES:
GRAPHIC SCALE
KEY MAP
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SEWER

Exhibit E.1 Letter from Napa Sanitation District

Dedicated to Preserving the Napa River for Generations to Come

935 HARTLE COURT
P.O. BOX 2480
NAPA, CALIFORNIA 94558-0522
TELEPHONE (707) 258-6000
FAX (707) 258-6048

September 16, 2009

Keith H. Rogal
Rogal + Walsh + Mol
5 Third Street, Suite 1014
San Francisco, CA 94103

Re: Napa Pipe Development

Dear Mr. Rogal:

The Napa Sanitation District Board of Directors has considered your letter dated June 1, 2009, regarding the District's wastewater treatment preference for the Napa Pipe Development site. The Board has determined that the Napa Sanitation District will provide wastewater collection and treatment for the proposed Napa Pipe Development, subject to all applicable rules and regulations of the District and upon payment of the appropriate fees for service. Conditions of approval will be established by the District at the time a formal application is submitted to the County of Napa Planning Department.

District planning documents rely on City of Napa and County of Napa General Plans to estimate future flows. Because neither document projected the proposed level of development for the Napa Pipe site, the District has not evaluated its capacity to serve the project. Prior to expansion of service at the Napa Pipe site, the District will require the Developer to fund a study to determine the project impacts on the District's collection, treatment, and water recycling systems, and to fund necessary improvements to mitigate project impacts.

Sincerely,

Jill Techel

Jill Techel
Chair, Napa Sanitation District Board of Directors

Encl: June 1, 2009 letter

SANITATION MITIGATIONS

Exhibit F.1 GHD Memorandum

Memorandum

October 25, 2013

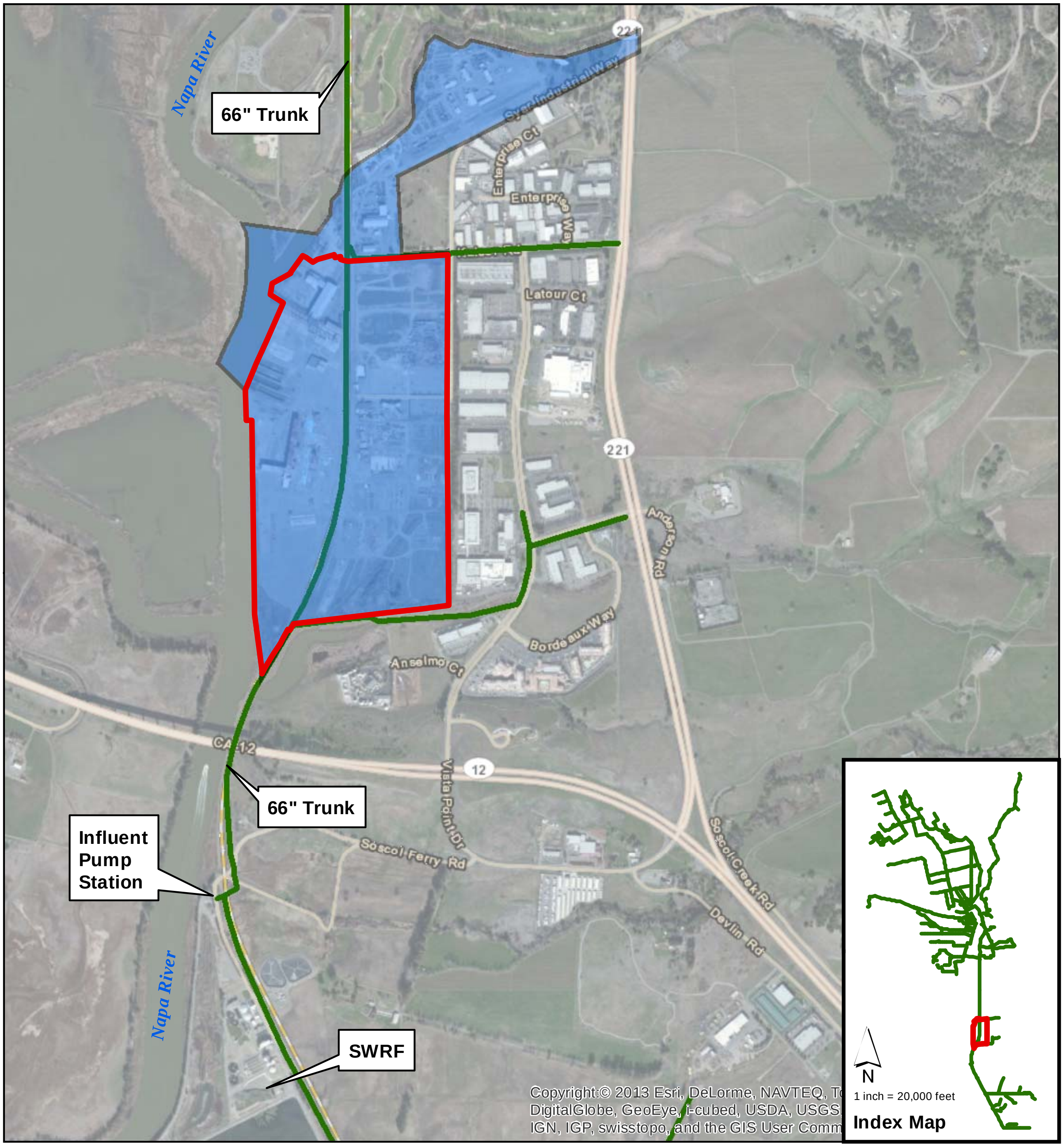
To:	Robin Gamble Holley, Napa Sanitation District
Cc:	
From:	Adam Fisher, Project Manager Matt Winkelman, Project Engineer — Tel: 707.523.1010
Reviewed:	Ted Whiton
Subject:	Napa Pipe Collection System Impact Analysis — Job no.: 8410892

BACKGROUND AND PURPOSE

Napa Redevelopment Partners (NRP) is proposing to develop the 154-acre site at 1025 Kaiser Road in unincorporated Napa County located between the Napa River and Highway 221, north of the intersection of Highway 12 and Highway 29 and within Traffic Area Zone (TAZ) 156. A Draft Environmental Impact Report (DEIR) and a supplement to the DEIR have been prepared for the Napa Pipe Project (Project). The District is evaluating potential impacts to its sanitary sewer collection system (CS) and influent pumps station (IPS) resulting from the proposed Project. The proposed Project's basic concept is to build a high-density mixed-use residential neighborhood on the northern portion of site. Along with residential housing, the Project includes private open space (parks, recreation areas, and CSA farm), senior housing, retail businesses, restaurants, a hotel, a business park, light industrial warehousing and office space. GHD's evaluation of the development's impacts on the District's sewer system is based on NRP's current land use proposal.

The existing IPS was constructed in 1966 and conveys all sanitary sewer flow from the District's collection system to the Soscol Water Recycling Facility (SWRF). Figure 1 provides the Project location relative to the IPS and SWRF. As evidenced during wet weather storm events and through discussion with District operations staff, the IPS has limited capacity to handle peak wet weather flows and diminished reliability to remain fully functional during high flow events. In 2009, Winzler & Kelly (now GHD) completed a study (IPS Study) which included a review of previous seismic and capacity issues related to the IPS. The Study also provided recommendations for improvements and/or replacement of the IPS to meet reliability and capacity requirements for the future. The firm hydraulic capacity (maximum capacity with the largest pump out of service) for the IPS is 25 million gallons per day (mgd), and the peak flow rate calculated in the 2007 Collection System Master Plan (CSMP) approaches 90 mgd. Conveyance system capacity constraints limit the peak flow received at the SWRF, therefore the immediate firm capacity requirement at the IPS is 60 mgd.

GHD Inc.
1735 North First Street, Suite 301, San Jose, CA 95112 USA
T 1 408 451 9615 F 1 408 451 9665 E sanjose@ghd.com W www.ghd.com



TAZ 156 (227 acres)

Project Site (154 acres)

2007 Modeled Pipelines

Paper Size 8.5" x 11" (ANSI A)
0 350 700 1,050 1,400
Feet
Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California II FIPS 0402 Feet

Napa Sanitation District
Napa Pipe Impact Study

Job Number 8410892
Revision 0
Date 22 Oct 2013

Project Overview

Figure 1

The proposed Project would connect to the District's existing 66-inch diameter gravity trunk sewer utilizing a combination of new gravity sewers (6-inch to 15-inch diameter) within the Project property. Evaluation of the existing CS will include review of proposed sewer improvements, hydraulic modeling of the District's existing trunk CS for the portion of the system affected by Project flows, use of the District's current hydraulic design criteria, and review of existing and proposed sewers within the Napa Pipe property to estimate inflow and infiltration (I/I) contributions to CS flows.

During preparation of the CSMP, the District met with County planning staff to discuss the TAZ 156 site and identified the potential for the development of 2,353,000 ft2 of mixed commercial and industrial use based on the projected number of employees (6,825) and an allocation of 1,000 ft2 per every 2.9 employees [6,825 / (2.9/1,000) = 2,353,000]. Applying a unit flow estimate of 101 gallons per day (gpd) per 1,000 ft2 of commercial/industrial space, the estimated daily flow from the TAZ 156 is 237,653 gpd [2,353,000 / (1000/101) = 237,653]. Daily flow converted to equivalent dwelling units (EDUs) when applying the District's single family residence flow of 176 gpd per dwelling unit equals 1,350 EDUs [237,653 gpd / (176 gpd/DU) = 1,350 EDU]. The TAZ 156 site comprises 227 acres.

According to the current NRP land use proposal, the Napa Pipe Project site includes a total of 154 acres, of which, approximately 4.3 acres is wetland. Therefore, the total acreage for Napa Pipe that will be used in the hydraulic analysis will be 149.7, or approximately 66% of TAZ 156 [154–4.3 = 149.7].

The purpose of this Technical Memorandum (TM) is to summarize key Project design parameters necessary to provide the framework for the modeling analyses in order to facilitate a thorough understanding of potential impacts to the District's CS and IPS, and to make recommendations regarding future District projects. The sewer flow information, and the subsequent hydraulic evaluation in this TM will also be used by the District for evaluation of the Project's impacts on the SWRF and recycled water system (by others).

The base existing model used for the evaluation of Napa Pipe flows includes year 2030 design flows which were quantified in the Collection System Master Plan (CSMP). Year 2030 flows were derived based on CSMP assumptions that certain constrictions in the collection system upstream of TAZ 156 had been eliminated through construction of CIP projects recommended in the CSMP.

The purpose of this TM is to evaluate hydraulic modeling results based on the incremental impact of the proposed Napa Pipe Project to the District's existing CS and IPS using year 2030 design flows and including the assumption that a new parallel trunk main will need to be constructed. Modeling results presented in this TM include analysis of Project flows in order to size a new trunk main capable of conveying incremental Project flow while meeting District standards. The existing 66-inch trunk main is over capacity (d/D > 0.9); consequently a new main is required to convey incremental project flows. The current developmental plan identifies this new main as a 15" pipe, however, the hydraulic analysis performed as part of this TM indicates a size of 12". This TM also includes recommendations for improvements to the District's CS and IPS. Modeling assumptions include:

EXHIBIT F

NAPA PIPE DEVELOPMENT PLAN: DRAFT

III. DEVELOPMENT STANDARDS

III.1 USES OF THE PROPERTY

EXHIBIT 2: LAND USE PLAN

WESTERN PARCEL (APN 046-412-005)

- 700 dwelling units of mixed type, or 945 dwelling units with state density bonuses
- Parks and recreation areas
- 150-unit Senior Housing (CCRC)
- 150-suite hotel with associated uses
- 40,000 square feet of neighborhood retail and restaurants
- 10,000 square feet of office

EASTERN PARCEL (APN 046-400-030)

- 90,000 square feet of office
- Parks, Recreation Areas, and CSA Farm
- 75,000 square feet of Light Industrial / R&D / Warehousing
- 154,000 square feet of Costco

KEY TO LAND USES

- Publicly Accessible Parks and Open Space
- Farm
- Area for Seniors Housing (CCRC)
- Possible Location of Ground-Floor Retail (Residential Above)
- Area for Community Buildings
- Area for Hotel and Accessory Uses
- Areas for Office, R&D, Warehouse, and/or Light Industrial Uses
- Area for Membership Warehouse Club Retail
- Mix of Apartments, Condominiums, Rowhouses, Carriage Houses, and Single-Family Housing (Courtyard Homes)

NAPA PIPE | NAPA REDEVELOPMENT PARTNERS

DRAFT FOR REVIEW   AUGUST 21, 2013 | 73

Paper Size 11" x 17" (ANSI B)

Not To Scale

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California II FIPS 0402 Feet

N

LEGEND

Napa Sanitation District
Napa Pipe Impact Study

Job Number	8410892
Revision	0
Date	22 Oct 2013

Development Land Use

Figure 2

N:\US\Santa Rosa\W&K\Projects\02461 - Napa Sanitation District\02461-8410892 NSD Pipe Impact Study\08-GIS\Maps\Figures\Figure 2 Development Land Use.mxd

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afisher2

2235 Mercury Way Suite 150 Santa Rosa CA 95407 USA **T** 707 523 1010 **F** 707 527 8679 **E** santarosa@ghd.com **W** www.ghd.com

- There are no existing capacity restrictions downstream of the CS (i.e., the connection point from the CS to the IPS is a free outfall). The CS hydraulic model assumes that the IPS is capable of handling year 2030 flows as well as incremental Project flows without increasing the CS hydraulic grade line).
- The proposed parallel trunk maintains a straight line grade between segments.
- Capacity restrictions upstream of TAZ 156 have been removed.

PROPOSED PROJECT SUMMARY

The proposed Project amends the County's General Plan and zoning ordinance, and would result in phased construction of mixed-use development, including residential, retail, light industrial /warehousing/office space, hotel, CSA farm, and open space. Consideration of potential impacts to the CS and IPS is based on the proposed development plan (see Figure 2). Table 1 includes proposed land use types with associated sizes. As proposed, the development's collection system would connect to the existing 66-inch trunk sewer.

Table 1: Current Land Use Proposal Type by Size

Land Use Type	Size
Residential Housing	945 units
Office/R&D/Light Industrial/Warehousing/Costco	329,000 square feet
Retail/Restaurants	40,000 square feet
Senior Housing Facility	150 units
Hotel	150 suites
Open Space	29.9 acres
CSA Farm	3.5 acres
Wetlands	4.3 acres

MODELING PARAMETERS

The CSMP describes the design criteria used for developing the collection system CIP. This section includes information on flow factors, infiltration and inflow (I/I), depth-to-diameter (d/D) ratios, and Manning's coefficient that are consistent with these criteria.

Several model runs were prepared for the CSMP. The hydraulic evaluation will consider one model scenario that is based on 2030 build-out conditions and NRP's current land use proposal. The assumptions that were used in the CSMP for the construction of the 2030 build-out model run will be used for the evaluation of Napa Pipe's impacts to the collection system and IPS.

Flow Factors

Initial estimates of average number of persons per residential dwelling and associated flow rates were provided in the Draft EIR. However, District and NRP have agreed upon the use of the District's current hydraulic design criteria in conjunction with the projected units in the Draft EIR for a "Mid-Range Density Alternative". That alternative has now been replaced by NRP's current land use proposal. Table 3 includes unit flow factors by use type, including projected units and estimated flows. The individual uses listed in Table 3 do not include allocations for public facilities such as the swimming pool, nature center, daycare noted in the Mid-Range Density Alternative and others since they were not quantified in the DEIR.

Table 3: Unit Flow Factor and Projected Wastewater Flows

Description	Projected Units	Napa Sanitation District	
		Unit Flow Factor (gpd/unit)	**Estimated Flow (gpd)**
Residential Dwelling Unit [a]	945	176/unit	166,320
Senior Residential Dwelling Unit	150	176/unit	26,400
Industrial/Office/R&D/Warehousing (per 1,000 ft^2)	329	101/1,000 ft^2	33,229
Retail/Restaurants (per 1,000 ft^2)	40	101/1,000 ft^2	4,040
Wastewater Generated per Condominium Hotel Unit (gpd)	150	176/Unit	26,400
Average Daily Flow (gpd) [b]	**-**	**-**	**256,389**
Peak Hour Dry Weather Flow (gpd) [c]	**-**	**2.77**	**710,198**
Peak Hour Wet Weather Flow (mgd) [d]			**0.77**
Total EDUs			**1,457 [e]**

Notes:
[a] Per Association of Bay Area Governments, assumes 2.61 persons per residential dwelling unit at a flow rate of 67.3 gallons per day per person (per CSMP).
[b] Total gallons per day for average dry weather flow.
[c] Peak hour flow rate includes 2.77 peaking factor.
[d] Peak hour flow rate includes I/I flow rate of 500 gpd/acre (116.3 acres; see calculation below)
[e] Total EDUs = Average Daily Flow (256,389 gpd) / 176 gpd/EDU = 1,457 EDUs.

Peaking Factors

NSD has established a peaking factor curve (Figure 10-1) in its *Sanitary Sewer and Recycled Water Standards* (March 2012) to calculate the peaking factor between average daily flow and peak hour dry weather flow. Using the average daily flow of 256,389 gpd (0.26 mgd), the peaking factor is 2.77, which has been applied to the Project. This PF is based on impact to the District’s CS, IPS, SWRF, and includes effects from anticipated flow attenuation based on the size of the Project.

I/I and Determination of Peak Hour Wet Weather Flow

The following methodology will be utilized to estimate the inflow and infiltration (I/I) flow rate for the collection system: Assign number of gallons based on total acres served (gpd/acre). The District’s current hydraulic design criterion is a flow rate of 500 gpd/acre for I/I contribution.

The I/I flow rate will be added to the peak hour dry weather flow rate provided in Table 3 to calculate the peak hour wet weather flow rate.

Using the District's gpd/acre metric of 500 and excluding the planned 29.9 acres of open space, the 3.5 acres of CSA farm, and 4.3 acres of wetland, the I/I contribution would be a flow rate of approximately 58,150 gpd [(154 – 29.9 – 3.5 – 4.3) x 500 = 58,150].

EDU Flow Credit

Per the CSMP, 237,653 gpd is attributed to TAZ 156. The Napa Pipe Project site includes a total of 149.7 of the 227 acres within TAZ 156, or approximately 66% of the flow. Per Table 3, the proposed development has a daily flow rate of 256,389 gpd, which is an incremental increase of 99,664 gpd for the development's acreage within TAZ 156.

256,389 gpd – [237,653 gpd x (149.7 ac /227 ac)] = 99,664 gpd

The hydraulic model will be updated with this incremental increase in flow for the Napa Pipe Project site to analyze impacts to the collection system and the IPS. The incremental increase in daily flow rate is converted to a peak hour wet weather flow rate as follows:

[99,664 gpd x 2.77 (PF)] + [(500 gpd/ac) x 116.3 ac] = 334,219 gpd (0.33 mgd).

d/D Ratio

Design depth-to-diameter (d/D) ratios typically range from 0.5 to 0.9. The District designs new sewers to flow at 0.7 d/D during peak wet weather flow conditions, although values between 0.7 and 0.9 may be present in the existing system. Capacity increase projects are considered by the District when d/D is greater than 0.9. Per the CSMP, during peak wet weather flows for Year 2005 conditions, the existing 66-inch is hydraulically-limited, with a d/D ratio in excess of 0.9.

Manning's Coefficient (n-value)

Pipe friction is primarily a function of the pipe material. An n-value of 0.013 has been established by the District for its current hydraulic design criteria.

MODEL INPUTS

The current model reflects a combination of information derived in this TM as well as the CSMP. The current hydraulic evaluation considers one model scenario that is based on the planned development. The modeling assumptions stated above have been applied to the current modeling effort for the evaluation of the Napa Pipe impact to the collection system and IPS. Table 4 includes model parameter input values.

Table 4: Model Inputs

Model Parameter	Value
Napa Pipe flow	0.33 mgd (includes I/I)
n-value	0.013
Pipe slope	0.0020 [1]

Pipe length	6,623 ft

[1] The downstream crown elevation of the proposed trunk was matched to the crown elevation of the existing 66-inch trunk (el.-5.76 ft) at the IPS. A constant minimum slope per District standard was assumed. The resulting upstream crown elevation of the proposed 12-inch trunk is 6.91 ft., resulting in 1.59 ft of cover (upstream rim elevation = 8.5 ft.).

MODEL RESULTS

Collection System

A second trunk main was added to the model and sized to convey the incremental Project flow. The estimated Project peak hour wet weather flow is 0.77 mgd, and the incremental flow increase is 0.33 mgd. Table 5 includes d/D values and velocities for the proposed 12-inch diameter trunk main for both of these flow rates.

Table 5: Model Results for 12-inch Diameter Trunk

Flow (mgd)	d/D	V (fps)
0.77	0.64	2.24
0.33	0.39	1.82 [1]

[1] District standard for minimum flow velocity is 2 fps for average dry weather flow.

The d/D values for the proposed 12-inch trunk main are less than 0.7 per District design guidelines. Pipe diameter was modeled iteratively, and a 10-inch diameter trunk was not feasible since the resulting d/D values were greater than 0.7. Note: The flow velocity would be less than 2 feet per second (fps) for average and peak dry weather flows, which does not meet the District's minimum flow velocity standard.

Using the District's minimum pipe slope for a new 12-inch main, the anticipated pipe cover at the northern end of the main extension would be approximately 1.5 feet. This is less than the District's minimum standard for pipe cover of 3 feet. Accordingly, detailed design of the new main and project site will need to consider additional pipe cover.

IPS

The current maximum capacity of the IPS is 58 mgd with all pumps in simultaneous full-speed operation (the firm capacity of the existing IPS is 25 mgd). Pursuant to information presented in the CSMP and subsequently in the IPS Seismic Study and Replacement TM (W&K, 2009) and April 2011 Wastewater Treatment Plant Master Plan, peak hour wet weather flows at the IPS could approach 90 mgd if collection system capacity deficiencies are corrected and there is no reduction in infiltration and inflow (I&I) in the system. Conveyance system capacity constraints currently limit the peak flow received at the IPS, therefore the near-term firm capacity requirement at the IPS is 60 mgd.

Therefore, firm pumping capacity at the IPS would need to be increased to accommodate the projected 0.33-mgd incremental increase in peak hour wet weather flow from the collection system. Attenuation of the incremental increase in flow of 0.33-mgd would be minimal since the Project is located at the downstream end of the collection system. Project flows should be considered in future analysis of the IPS to determine near and long-term impacts on IPS pump station hydraulics.

MITIGATION

Incremental Project flows may not be conveyed in the existing 66-inch trunk since the trunk is hydraulically limited with a d/D ratio in excess of 0.9. However, it is possible that a reduction in peak wet weather flow in the existing 66-inch trunk could provide sufficient capacity to enable introduction of Project flows into that same pipe without exceeding d/D = 0.9. The following bullet points summarize potential mitigation options the District may consider:

- Project owner contributes funds to the District for I&I reduction in the upstream CS to offset Project flows, where the decrease in flow due to I&I reduction would need to be greater than any incremental flow increases resulting from the Project.
- Project owner constructs a new 12-inch trunk main to convey Project flows to the IPS. Note: NRP would need to determine the alignment for this option, as the District's easement for the existing 66-inch trunk sewer is not intended to include three sanitary sewer pipelines (i.e., existing 66-inch, future District trunk sewer, and the 12-inch Project trunk sewer).

I&I Reduction

Per District Resolution No. 11-025, a proposed development that significantly exceeds the growth projected in the CSMP, and thereby would contribute additional peak flows into the District's collection system, may mitigate for its flow increase at a 2:1 mitigation ratio. This ratio is based on two primary factors:

1. Depending on the location and type of I&I rehabilitation work, collection system flows from that location could be attenuated prior to reaching the portion of the trunk sewer impacted by the incremental flow increase; and
2. The rehabilitated and/or replaced portions of the existing sewer collection system will degrade over time, which can result in a future increase in I&I at those locations.

System degradation is anticipated to occur at a rate of 20-percent over a 30-year planning horizon, which is based on an approximate rate of 7 percent per decade. The 30-year planning horizon is typical for wastewater planning documents. However, this is somewhat less conservative compared to the anticipated service life of rehabilitated sanitary sewer pipelines, which could exceed 50 years.

NRP shall pay for the District to install flow monitors in the collection system immediately downstream of the I&I reduction project during the wet weather seasons before and after the I&I reduction project is constructed. Measured reduction in I&I must meet or exceed development project peak wet weather flow impacts on a 2:1 mitigation ratio (0.33 mgd x 2 = 0.66 mgd).

The location and project scope of the I&I rehabilitation work shall be determined in collaboration with the District, with the project implemented by the District utilizing owner-contributed funds. The rehabilitation project shall completely rehabilitate the public sewer system between manholes, inclusive of lower laterals, upstream of the pipeline identified in the CSMP as under capacity during peak wet weather flow.

The District will administer a design and construction project for the rehabilitation project in accordance with standard District procedures.

Construction of a new trunk main would mitigate for the CS impact only, whereas I&I reduction would reduce impacts to both the CS and IPS. The incremental increase without I&I reduction in flow would have an impact on the IPS by increasing the near-term pumping capacity at the IPS by 0.33 mgd. Accordingly, mitigation measures would also be needed for the IPS. The District may consider the following mitigation options for the incremental flow increase on the IPS:

- NRP contributes funds to the District for detailed analysis and/or construction costs at the IPS associated with additional capacity. Contribution may be flow based or a share of the IPS construction cost; and
- I&I reduction in the upstream CS to offset Project flows. Similar to mitigation for the collection system, I&I reduction would need to achieve a flow rate greater than the incremental increase.

SANITATION MITIGATIONS

Exhibit F.2 Wastewater Treatment Plant Impact Analysis Addendum

Brown AND Caldwell

FINAL

Prepared for
Napa Sanitation District

Napa Pipe Wastewater Treatment Plant Impact Analysis Addendum

January 2014

FINAL

Napa Pipe Wastewater Treatment Plant Impact Analysis Addendum

Prepared for
Napa Sanitation District
November 2013

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List of Abbreviations

AA	average annual
ADWF	average dry weather flow
ADWL	average dry weather load
ADWMM	average dry weather maximum month
AF	acre-feet
AWWMM	average wet weather maximum month
BOD	biochemical oxygen demand
CIP	Capital Improvement Program
CSMP	Collection System Master Plan
District	Napa Sanitation District
EDUs	equivalent dwelling units
FOG	fats, oils and grease
gpd	gallons per day
hp	horsepower
I/I	infiltration and inflow
IPS	influent pump station
lb/day	pounds per day
lb BOD/day	pounds biochemical oxygen demand per day
LOS	level of service
MD	maximum day
MG	million gallons
mgd	million gallons per day
MW	maximum week
PDWF	peak dry weather flow
PHWWF	peak hour wet weather flow
Plan	Master Plan
PWWF	peak wet weather flow
RAS	return activated sludge
sf	square foot
SRT	solids residence time
TSS	total suspended solids
WWTP	Wastewater Treatment Plant

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Executive Summary

The Napa Sanitation District (District) prepared a Master Plan for its Wastewater Treatment Plant (WWTP) (Brown and Caldwell and Carollo Engineers, April 2011). The primary WWTP Master Plan goal was to provide adequate wastewater treatment capacity through 2030, based on meeting District-defined levels of service (LOS) at the lowest practical cost. The WWTP Master Plan, which forms the basis for this report, included some allowance for new development at the Napa Pipe site south of the City of Napa. Subsequent to completing the WWTP Master Plan, the District directed Brown and Caldwell and Carollo Engineers to determine how more intensive development on the Napa Pipe site might affect the WWTP capacity and the balance between discharge to the Napa River and supply of recycled water. The Napa Pipe Wastewater Treatment Plant Impact Analysis was prepared in December 2011 to analyze the proposed project (Brown and Caldwell and Carollo Engineers, 2011). This report is an addendum to the December 2011 report, addressing recent changes to the Napa Pipe development plan.

Key parameters for determining required WWTP capacity are flow and organic loading. The expanded Napa Pipe development would increase flow and loading projections to the WWTP by about 1.2 percent over the values used in the WWTP Master Plan. Since the schedule for build out at the Napa Pipe site is unknown, analyses for this report assume that development would be spread uniformly through 2030. Increased flow and loading from an expanded Napa Pipe development would affect the size and timing of several proposed WWTP improvements. Table ES-1 presents the summary information from the WWTP Master Plan updated for impacts from the expanded Napa Pipe development. The aeration basin expansion and completion of the second digester would need to accelerate. The Phase 2 Recycled Water Expansion project and a new project to add more aerators would need to occur before 2030. Adding aerator capacity increases the projected capital cost for scheduled projects by $900,000 (April 2010 dollars) compared to the WWTP Master Plan.

In 2030, the available recycled water supply would increase by 100 acre feet (AF) or less annually compared to values presented in the WWTP Master Plan, depending on the District’s strategy for operating storage within the oxidation ponds. The peak recycled water demand would increase by about 0.2 million gallons per day (mgd). Since the total flow increase from the expanded Napa Pipe development is small compared to the overall WWTP influent flow, the frequency of emergency summer discharge would remain unchanged compared to WWTP Master Plan projections. The frequency would continue to depend on whether the District chooses to operate the ponds nearly full or nearly empty on May 1. About one year in 10, the District would have to curtail recycled water deliveries due to dry conditions.

Table ES-1. Project Implementation Summary with the Expanded Napa Pipe Development

Project	Capital Cost Million $[1]	Trigger to Begin Predesign	Permitting, Design and Construction Duration, months	Priority[2]	Project Completion Date
Flocculating Clarifier Weirs	0.6	ADWF of 6.8 mgd (2011)	10	A	2012
Full-Scale Testing of Flocculating Clarifier Effluent to Activated Sludge	0.3	Peak day recycled water demand of 5.1 mgd and Phase 1 Recycled Water Expansion not on-line	NA	A	2012[3]
Purchase Spare Digester Mixer	0.4	Redundancy – start in 2011	10	A	2012
Increase Pond Aeration (Add 125 hp)	2.2	AA BOD loading of 18,700 lb/day (2011)	23	A	2013
Recycled Water Jockey Pump	0.2	Reduce maintenance - immediate (2011)	24	A	2013
Activated Sludge Diffuser Replacement	0.9	Condition/age - start in 2011 based on useful life of existing equipment	25	C	2013
Pond Improvements – Phase 1	0.1	Condition/age - immediate (2011)	25	C	2013[4]
Pond Improvements – Phase 2	2.8	Condition/age - immediate (2011)	25	A	2013[5]
Tertiary Treatment Improvements	1.1	Condition/operational enhancements - immediate (2011)	24	C	2013
3W System Improvements	0.3	Condition/operational enhancement - immediate (2011)	24	C	2013
Solids Handling Improvements	0.8	Operational enhancements – immediate (2011)	31	C	2014
IPS Expansion	15.5	PHWWF of 25.0 mgd (2011)	48	A	2015
Phase 1 Recycled Water Expansion	13.9	Four years before peak day recycled water demand exceeds 5.1 mgd (2011) or ADWF of 7.0 mgd (2012)	50	A	2015
Line Recycled Water Reservoir	0.2	Recycled water storage needs	23	C	2015
Headworks Improvements	1.2	Condition/age - start in 2014 based on useful life of existing equipment	25	C	2016
Primary Treatment Improvements	0.3	Operational enhancements. Start in 2014 in parallel with Headworks Improvements.	22	C	2016
Complete Egg-Shaped Digester	11.4	Maximum month sludge loading of 24,700 lb/day (approximately AA influent TSS loading of 20,600 lb/day) (2018)	46	B	2022
Aeration Basin Expansion	4.2	AA BOD loading of 20,000 lb/day (2020) or ADWF of 7.4 (2020)	40	B	2024
Phase 2 Recycled Water Expansion	4.9	Four years before peak day recycled water demand exceeds 11.1 mgd or ADWF of 8.0 (2025)	38	B	2029
Increase Pond Aeration (Add 50 hp)	0.9	AA BOD loading of 22,400 lb/day (2027)	23	B	2029
Base Project Total	**62.2**				

[1]Costs were determined for April 2010 for Napa, California, using the San Francisco ENRCCI (ENR construction cost index) of 9,730.
[2]Priority A indicates projects required to accommodate capacity by 2016, projects critical for reliability of WWTP operations, and projects expected to save significant maintenance cost. Priority B projects accommodate capacity increases after 2016. Priority C projects are mainly facilities condition/age related.
[3]Testing will take approximately one year, so results could be available by 2012.
[4]Install transfer structures between Ponds 1 and 2.
[5]Install replacement aerators, remaining transfer structures and distribution piping. The District may choose to delay some parts of this project, to reduce early expenditures. Aerator replacement is most important.

Section 1

Introduction

1.1 Objectives

This report's objective is to summarize how Napa Sanitation District (District) could treat wastewater flows and loadings from a proposed expanded development on the Napa Pipe site (sponsored by Napa Redevelopment Partners, LLC—NRP) at its wastewater treatment plant (WWTP). The proposed development includes a high-density mixed-use residential neighborhood on the northern portion of the site. Along with residential housing, the Project includes private open space (parks, recreation areas, and CSA farm), senior housing, retail businesses, restaurants, a hotel, a business park, light industrial warehousing and office space. The work is based on the WWTP Master Plan (Plan) (Brown and Caldwell and Carollo Engineers, 2011). The Plan included some limited development on the Napa Pipe site, but the proposed expanded project exceeds this amount. The Napa Pipe Wastewater Treatment Plant Impact Analysis was prepared in December 2011 to analyze the proposed project (Brown and Caldwell and Carollo Engineers, 2011). This report is an addendum to that report incorporating changes to the Napa Pipe development plan. This report analyzes the impacts of the additional flow and loading. This report addresses only impacts on the WWTP. Reports prepared by others for the District address impacts on the collection system and recycled water distribution system.

1.2 Summary of WWTP Master Plan Results

The Plan forms the basis for this report. This section summarizes results from the Plan. The primary Plan goal was to provide adequate wastewater treatment capacity through 2030, based on meeting District-defined levels of service (LOS) at the lowest practical cost. LOS describes the District's targets for how it delivers service to its customers and operates its business. The Plan assumed that permit requirements from the 2010 permit renewal cycle (adopted in February 2011) will apply throughout the 20-year planning period, i.e., no more stringent requirements in future permit cycles up to 2030.

The Plan used population projections and commercial growth estimates based on the most recent City of Napa and Napa County General Plans to derive likely future flows and loadings. Average dry weather flow (ADWF) was projected to increase from the current 6.8 million gallons per day (mgd) to 8.6 mgd in 2030. Organic, solid and nutrient loadings were projected to increase in proportion to increasing flows; thus, pollutant concentrations (e.g., biochemical oxygen demand [BOD], total suspended solids [TSS] and ammonia) essentially would remain constant, and equal to current concentrations, over the planning horizon.

The Plan projected that un-attenuated peak hour wet weather flow (PHWWF) would increase from the current 86.4 mgd to 89.9 mgd by 2030. The collection system has conveyance capacity constraints that limit the peak flow received at the WWTP; thus, the immediate firm capacity requirement is 60 mgd. Depending on the results of the District's infiltration and inflow (I/I) reduction efforts and collection system upgrades, the firm capacity might need to increase to accommodate as much as 90 mgd as stated in the Collection System Master Plan (Winzler & Kelly, 2007). The Plan is based on a 60-mgd firm capacity, with provisions to expand if necessary.

The Brown and Caldwell/Carollo Engineers team developed a water balance model to model climatic variations effecting evaporation and irrigation, and to project recycled water demands. Modeling predicted irrigation water deficits in dry years and emergency discharges in wet years. Varying irrigation on District-controlled lands would reduce, but not eliminate, the need for emergency discharges. Using the currently available storage in the oxidation ponds and varying annual irrigation volumes on District land, the District could supply an average of 3,700 acre-feet (AF) of water based on current wastewater flows while limiting emergency discharges to approximately once in nine years. With increased WWTP influent flows, the District could increase recycled water supply to an average of 4,500 AF, but emergency discharges would occur more than every two years. For either of these median year recycled water delivery volumes, the District would need to curtail its recycled water deliveries about once in 10 years due to drier conditions. The District also could supply additional water during the winter months. To supply 1,800 AF during the off-season, water deliveries must begin by November 1 and continue through the winter.

The Plan identified several key capacity limitations:

- Influent pumping station firm capacity (25 mgd) is significantly less than current attenuated peak hour flows (60 mgd).
- BOD loading capacity is limited under worst winter weather conditions to an annual average loading of 18,500 pounds biochemical oxygen demand per day (lb BOD/day) (approximately 6.8 mgd ADWF), which is equivalent to the loading from about 38,500 equivalent single-family dwelling units, also known as equivalent dwelling units (EDUs). Total loading currently is about 38,300 EDUs.
- Winter river discharge capacity is limited to 20.7 mgd (approximately 7.1 mgd ADWF).
- Recycled water production is limited by filtration capacity to 5.1 mgd.
- Solids handling facilities are limited by anaerobic digestion with the capacity to treat solids from an ADWF of 7.5 mgd.

The District developed and screened alternatives for both its liquid (six) and solids (three) systems and selected a recommended project. A comprehensive business case evaluation of alternatives included developing capital and life-cycle costs for all nine alternatives and using a pair-wise comparison evaluation approach that considered economic and non-economic factors. All alternatives met the District-developed core LOS. For all alternatives, the existing oxidation ponds could treat diluted winery wastes received in the summer and fall.

The recommended project uses all major facilities in the existing WWTP. It would gain capacity for growth and increased recycled water demand by expanding existing unit processes. Additionally, expected future improvements would strand no investment in existing or new facilities. The Plan presents the “trigger points” (capacity limits or demand requirements) that define when the District needs modified or new facilities, combined with the lead time required for implementing each change. The lead time depends on the growth rate for flows and loading. The corresponding Capital Improvement Program (CIP) is $61.3 million. Table 1-1 presents a summary of proposed projects. Influent pumping, activated sludge capacity expansion, pond improvements, pond capacity expansion, recycled water production capacity, and a second sludge digester make up about 90 percent of the CIP; 12 smaller projects comprise the remainder.

Table 1-1. WWTP Master Plan Project Implementation Summary

Project	Capital Cost Million $1	Trigger to Begin Predesign	Permitting, Design and Construction Duration, months	Priority2	Project Completion Date
Flocculating Clarifier Weirs	0.6	ADWF of 6.8 mgd (2011)	10	A	2012
Full-Scale Testing of Flocculating Clarifier Effluent to Activated Sludge	0.3	Peak day recycled water demand of 5.1 mgd and Phase 1 Recycled Water Expansion not on line	NA	A	2012[3]
Purchase Spare Digester Mixer	0.4	Redundancy – start in 2011	10	A	2012
Increase Pond Aeration (Add 125 hp)	2.2	AA BOD Load of 18,700 lb/day (2011)	23	A	2013
Recycled Water Jockey Pump	0.2	Reduce maintenance - immediate (2011)	24	A	2013
Activated Sludge Diffuser Replacement	0.9	Condition/age - start in 2011 based on useful life of existing equipment	25	C	2013
Pond Improvements – Phase 1	0.1	Condition/age - immediate (2011)	25	C	2013[4]
Pond Improvements – Phase 2	2.8	Condition/age - immediate (2011)	25	A	2013[5]
Tertiary Treatment Improvements	1.1	Condition/operational enhancements – immediate (2011)	24	C	2013
3W System Improvements	0.3	Condition/operational enhancement – immediate (2011)	24	C	2013
Solids Handling Improvements	0.8	Operational enhancements – immediate (2011)	31	C	2014
IPS Expansion	15.5	PHWWF of 25.0 mgd (2011)	48	A	2015
Phase 1 Recycled Water Expansion	13.9	Four years before peak day recycled water demand exceeds 5.1 mgd (2011) or ADWF of 7.1 mgd (2014)	50	A	2015
Line Recycled Water Reservoir	0.2	Recycled water storage needs	23	C	2015
Headworks Improvements	1.2	Condition/age - start in 2014 based on useful life of existing equipment	25	C	2016
Primary Treatment Improvements	0.3	Operational enhancements - Start in 2014 in parallel with Headworks Improvements.	22	C	2016
Complete Egg-Shaped Digester	11.4	Maximum month sludge loading of 24,700 lb/day (approximately AA influent TSS loading of 20,500 lb/day) (2019)	46	B	2023
Aeration Basin Expansion	4.2	AA BOD loading of 20,200 lb/day (2021) or ADWF of 7.5 (2021)	40	B	2025[6]
Phase 2 Recycled Water Expansion	4.9	Four years before peak day recycled water demand exceeds 11.1 mgd	38	D	-[7]
Base Project Total	**61.3**				

[1]Costs were determined for April 2010 for Napa, California, using the San Francisco ENRCCI (ENR construction cost index) of 9,730.
[2]Priority A indicates projects required to accommodate capacity by 2016, projects critical for reliability of WWTP operations, and projects expected to save significant maintenance cost. Priority B projects accommodate capacity increases after 2016. Priority C projects are mainly facilities condition/age related. Priority D projects are unscheduled.
[3]Testing will take approximately one year, so results could be available by 2012.
[4]Install transfer structures between Ponds 1 and 2.
[5]Install replacement aerators, remaining transfer structures and distribution piping. The District may choose to delay some parts of this project to reduce early expenditures. Aerator replacement is most important.
[6]Triggered by AA BOD loading increase. River discharge capacity required in 2025.
[7]Project is triggered by peak day recycled water demand based on District plan to maximize recycled water delivery. Project timing will depend on recycled water demand.

Table 1-1 also shows the estimated implementation time and projected completion date. For the projects, existing deficiency or capacity needs drive implementation. The Plan also describes and develops costs for three projects that the District could implement to:

- Further increase recycled water production.
- Decrease effluent ammonia concentrations should regulations become stricter. Note that the projects considered did not include total nitrogen removal.

Enhance its facilities for completing maintenance activities by constructing a new maintenance building.

1.3 Report Organization

This work's objective is to evaluate how the District could treat wastewater flows and loadings from a proposed expanded development on the Napa Pipe site (sponsored by Napa Redevelopment Partners, LLC—NRP) at its WWTP. This report has three chapters. Chapter 1 introduces the project and provides relevant background information.

Chapter 2 covers updates to the basis of planning due to the expanded Napa Pipe development. The chapter presents revised flow and loading projections that include the expanded Napa Pipe development. Flow and loading increases are based on the flow projections and EDU projections prepared by GHD (October 2013). Revised results from the water balance presented below show impacts on recycled water demand. The regulatory framework, desired levels of service and reliability requirements are unchanged from the Plan.

Chapter 3 covers the impacts to the WWTP resulting from additional development on the Napa Pipe site (beyond the development already accounted for in the Plan). The evaluation considered hydraulics, required loading capacity, required river discharge capacity and recycled water capacity. Recommendations are included for expanding process alternatives from the Plan to accommodate additional flows and loadings. This report did not evaluate alternative processes.

Section 2

Basis of Planning

This chapter updates the basis of planning due to the expanded Napa Pipe development. The additional development on the Napa Pipe site results in increased flows and loadings to the Wastewater Treatment Plant (WWTP) beyond those included in the WWTP Master Plan (Plan), as well as increased recycled water availability. This chapter discusses these changes. The regulatory framework, desired levels of service and reliability requirements have not changed from the Plan and are not discussed.

2.1 Flows and Loads

Table 2-1 presents the various flow and load definitions used in this report, together with the purpose each will serve in planning future facilities.

Table 2-1. Wastewater Influent Flow and Load Definitions

Item	Definition	Purpose or Use
ADWF and ADWL	Average Dry Weather Flow The lowest 90-day average influent flow in the dry weather season (May through October). Average Dry Weather Load The average daily influent loading occurring during the same period ADWF is defined.	To develop base wastewater flow projections and to provide the basis for sizing certain treatment facilities. Also used to evaluate impacts of taking various process units out of service.
AA	Average Annual The average daily flow or loading for an annual period.	To evaluate annual power use for alternatives.
ADWMM	Average Dry Weather Maximum Month The highest 30-day average flow or load in the dry weather season (May through October). Note that maximum month flows and loads do not necessarily occur in the same month.	To size wastewater treatment facilities to meet 30-day NPDES permit requirements. Also used to evaluate impacts of taking various process units out of service.
AWWMM	Average Wet Weather Maximum Month The highest 30-day average flow or load in the wet weather season (November through April). Note that maximum month flows and loads do not necessarily occur in the same month.	To size wastewater treatment facilities to meet 30-day NPDES permit requirements.
MW	Maximum Week The maximum 7-day average flow or load. Note that maximum week flows and loads do not necessarily occur during the same period.	Used in nitrification or biological nutrient removal plants to determine the hydraulic and solids retention time (SRT) for nitrification and denitrification.
MD	Maximum Day The maximum day flow or load occurring during an annual period.	Together with consideration of diurnal variation, often used to determine aeration demands as well as to check maximum day discharge requirements.
PHWWF	Peak Hour Wet Weather Flow The peak hour plant influent flow resulting from a 10-year design storm (per Collection System Master Plan)	To set WWTP hydraulic capacity.

Brown AND Caldwell

Projections in Plan matched projections developed in the 2007 Collection System Master Plan (CSMP) (Winzler & Kelly, October 2007), which were coordinated with adopted City and County General Plans, and were reviewed with City and County planners. The ADWF projections from the 2007 CSMP are based on constant unit flow values, which imply that additional water conservation is not expected to reduce unit flow values. If additional water conservation occurs, pollutant concentrations would be expected to increase while loadings would be expected to increase faster than flows. Average loading projections assumed that the concentrations would remain the same in the future.

The WWTP capacity can be stated in terms of equivalent dwelling units (EDU)s. The Napa Sanitation District (District) can then convert the loading from a non-residential connection, say a restaurant, into EDUs based on loading. The District has established an average wastewater flow per household of 176 gallons per day (gpd). Analyses carried out for the Plan found that each EDU in the collection system delivers about 0.48 pounds per day (lb/day) of biochemical oxygen demand (BOD) to the WWTP.

GHD (Memorandum, October 25, 2013) evaluated the increased flows and EDUs from the proposed Napa Pipe development. The Plan included flow and loading estimates from the Napa Pipe site, but the proposed project now includes a larger flow and loading than anticipated. Table 2-2 summarizes the base influent flow and loadings from the proposed project. Cells highlighted in blue show the total WWTP influent including the Napa Pipe development. The 2030 total including the expanded Napa Pipe development serves as the basis for evaluating impacts on the WWTP. Figure 2-1 presents the same information graphically. Note that the incremental increase over the master plan is only 1.2 percent, which is within the error of many of the calculations.

Table 2-2. Base Influent Flow and Loadings

Item	2030 (Master Plan)[1]	Napa Pipe Project Total[2, 3]	Napa Pipe Project Incremental Increase Over Master Plan[3, 4]	2030 Total Including Napa Pipe Development
EDUs	48,300	1,457	566	48,900
ADWF, mgd[3, 5]	8.55	0.26	0.10	8.65
PHWWF, mgd[3, 5]	89.87	0.77	0.33	90.20
AA BOD, lb/day[5]	23,200	700	270	23,500
AA TSS, lb/day[5]	24,100	730	280	24,400
AA NH3-N, lb/day[5]	2,400	73	28	2,430

Notes:

[1]From Wastewater Treatment Plant Master Plan, April 2011, Brown and Caldwell and Carollo Engineers.

[2]Total flow and loading resulting from the proposed Napa Pipe development.

[3]ADWF, PHWWF, and number of EDUs from GHD (2013).

[4]The WWTP Master Plan included limited development on the Napa Pipe site. The incremental increase shows the flow and loading from the proposed Napa Pipe development that is not included in the Master Plan.

[5]Assuming 176 gal/EDU at ADWF, 0.48 lb BOD/day/EDU at AA, 0.50 lb TSS/day/EDU at AA, and 0.05 lb NH3-N/day/EDU at AA.

Figure 2-1 illustrates the increase in ADWF due to the proposed Napa Pipe project.

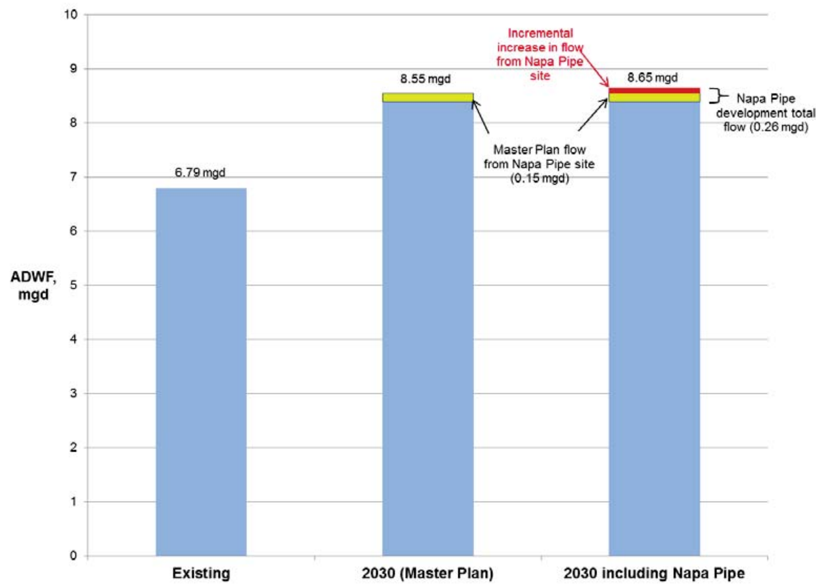

Figure 2-1. ADWF with Napa Pipe

Flow and loadings for other conditions were developed based on historical peaking factors relative to the ADWF condition, as determined in the plan. Table 2-3 presents flow and load projections for the WWTP. Cells highlighted in blue show the total WWTP influent including the Napa Pipe development.

Table 2-3. Flow and Load Projections for the WWTP Including Napa Pipe

Item	Existing (2006 - 2008)	Peaking Factor	2030 (Master Plan)	2030 including Napa Pipe Development [1]
ADW				
Flow, mgd	6.79	1.00	8.55	8.65
BOD, lb/day	17,500	1.00	22,100	22,400
BOD, mg/L	310	1.00	310	310
TSS, lb/day	17,500	1.00	22,100	22,400
TSS, mg/L	310	1.00	310	310
NH_3-N, lb/day	1,880	1.00	2,350	2,380
NH_3-N, mg/L	33	1.00	33	33
AA				
Flow, mgd	8.83	1.30	11.12	11.24
BOD, lb/day	18,400	1.05	23,200	23,500
TSS, lb/day	19,100	1.09	24,100	24,400
NH_3-N, lb/day	1,920	1.02	2,400	2,430
ADWMM				
Flow, mgd	12.23	1.80	15.40	15.57
BOD, lb/day	21,500	1.23	27,200	27,600
TSS, lb/day	25,200	1.44	31,900	32,300
NH_3-N, lb/day	2,410	1.28	3,020	3,050
AWWMM				
Flow, mgd	19.89	2.93	25.05	25.34
BOD, lb/day	26,300	1.50	33,200	33,600
TSS, lb/day	29,400	1.68	37,100	37,600
NH_3-N, lb/day	2,410	1.28	3,020	3,050
MW				
Flow, mgd	34.83	5.13	43.86	44.37
BOD, lb/day	34,500	1.97	43,500	44,100
TSS, lb/day	52,900	3.02	66,700	67,600
NH_3-N, lb/day	2,980	1.59	3,730	3,780

Table 2-3. Flow and Load Projections for the WWTP Including Napa Pipe

Item	Existing (2006 - 2008)	Peaking Factor	2030 (Master Plan)	2030 including Napa Pipe Development [1]
MD				
Flow, mgd	46.24	6.81	58.23	58.90
BOD, lb/day	48,700	2.78	61,400	62,300
TSS, lb/day	70,500	4.03	89,100	90,300
NH_3-N, lb/day	3,250	1.73	4,060	4,120
Attenuated Peak Hour Wet Weather Flow (PHWWF), mgd[2]	60		--	
Un-attenuated Peak Hour Wet Weather Flow (PHWWF), mgd[3]	86.37+		89.87	90.20

Notes:

[1]The WWTP Master Plan included limited development on the Napa Pipe site. The 2030 flow including the expanded Napa Pipe development includes the incremental increase from the proposed Napa Pipe development that is not included in the Master Plan.

[2]Attenuated flow to WWTP represents actual flow entering the WWTP. Projections are dependent on future capacity-related collection system improvements. Capacity improvements in the collection system will increase PHWWF to WWTP.

[3]Unattenuated flow represents instantaneous maximum flow in collection system. Actual flow into WWTP will be less due to flow attenuation, storage, and hydraulic limitations in the collection system.

PHWWF projections were based on projections made by Winzler & Kelly (CSMP, 2007) and GHD (2013) and only were provided for un-attenuated flow, which represented the total instantaneous flow in the collection system that would arrive at the WWTP if there were no attenuation, storage or hydraulic limitations. As presented above, projections show little difference between the existing and future un-attenuated flows.

The collection system has conveyance capacity constraints that limit the peak flow received at the WWTP; thus, the immediate firm capacity requirement is 60 million gallons per day (mgd). After the District upgrades the collection system to address capacity deficiencies, the firm capacity might need to be increased to handle 91 mgd; however, if the District's infiltration and inflow (I/I) reduction efforts prove to be successful, the PWWF at the WWTP would be something less than 90 mgd. For this Plan, a PWWF of 60 mgd will be assumed, similar to the Influent Pump Station Seismic Study and Replacement Technical Memorandum (Winzler & Kelly, May 2009).

2.2 Recycled Water Demand

To better plan for future recycled water system operation and understand likely available quantities for recycling, the District developed a water balance as part of the Plan. Water balance development resulted in a spreadsheet model that allows the user to estimate the statistics for recycled water availability based on irrigated acreage and recycled water use balanced against a 50-year climate record (rainfall and evaporation).

For this report, the water balance spreadsheet was revised to include the projected Napa Pipe development flows. Table 2-4 summarizes the key results of the water balance including the expanded Napa Pipe development. The results present estimates for a given set of initial conditions as to how frequently the District would run short of recycled water. The model also shows when the District might need an emergency discharge because its oxidation ponds were too full. Highlighted rows show the water balance results with the expanded Napa Pipe development flows.

Table 2-4. Water Balance Results Summary				
Scenario	Median Yearly Water Demand, AF[1]	Dry Yearly Water Demand, AF[2]	Peak Demand, mgd[3]	Return Frequency for Summer Emergency Discharge, yr[4]
Current ADWF, Ponds at Minimum Level on May 1	2,300	2,600	6.1	>52
2030 ADWF, Ponds at Minimum Level on May 1	3,000	3,400	8.3	7
2030 ADWF **with Napa Pipe**, Ponds at Minimum Level on May 1[5]	3,000	3,400	8.5	7
Current ADWF, Ponds Nearly Full on May 1[6]	3,700	4,200	10.8	13
2030 ADWF, Ponds Nearly Full on May 1[6]	4,500	5,100	13.8	2
2030 ADWF **with Napa Pipe**, Ponds Nearly Full on May 1	4,600	5,200	14.0	2

Notes:

[1]Does not include District-controlled land, but does include District land to be used in the future for golf courses or vineyards. During dry years, District-controlled land is assumed not to be irrigated. During wet years, District-controlled land is irrigated to minimize summer emergency discharge. Median District land demands were 800 AF per year.

[2]Dry years are based on a 10-year return frequency for protected shortfalls in deliveries, so District can supply sufficient water to meet user demands nine out of 10 years. In other words, the District has to limit or reduce deliveries about one in 10 years.

[3]Peak demand based on the peak 30-day demand from the model for the 10-year return frequency dry year, without any delivery curtailment. Further delivery curtailment may be required during peak week demand conditions.

[4]Assumes District-controlled land irrigated during wet years.

[5]Irrigated acreage increased with Napa Pipe, but the increase in yearly water demands was less than 100 AF.

[6]May 1 pond storage objective was set to store as much water as possible while preventing pond overflow in March and April during wet years. When ponds are nearly full on May 1, emergency discharge is frequently necessary in May.

The following provides key findings from the water balance:

- Because of climatic variations effecting irrigation demand and evaporation, balancing the need to supply sufficient water with the objective to avoid summer emergency discharges is difficult. Under all scenarios, the District runs short of water approximately once in 10 years during dry years. During wet years, summer emergency discharges are necessary.
- As dry weather influent flows to the WWTP increase, more water is available for reclamation. Conversely, as total annual dry weather flows to the WWTP increase and when yearly irrigation demand is low, ponds fill faster, which will require more frequent emergency discharges.
- Having land available where the District controls irrigation rates greatly increases the District's flexibility in delivering recycled water to its customers while minimizing emergency discharges.
- If the District were to maximize recycled water supplies for its customers by holding more effluent in its ponds going into the non-discharge season, such practices would increase the likelihood that the District would have an emergency discharge.
- Using the currently available storage in the oxidation ponds for current influent flows, the District could supply an average of 3,700 AF of water while limiting emergency discharges to approximately once in thirteen years.
- With increased WWTP influent flows projected in the Plan, the District could increase recycled water supply to an average of 4,500 AF, but emergency discharges would occur more than every two years. The additional flow from the expanded Napa Pipe development increases this

quantity further to 4,600 AF, and emergency discharges also would occur more than every two years.

- Additional water can be supplied during the winter months. To supply 1,800 AF during the off-season, water deliveries must begin by November 1 and continue through the winter.

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Section 3

WWTP Impacts

This chapter summarizes the projected impacts of the expanded Napa Pipe project on the Napa Sanitation District (District) Wastewater Treatment Plant (WWTP). The flows and loadings developed in Chapter 2 form the basis of the impacts analysis. The evaluation considered hydraulics, required loading capacity, required river discharge capacity, and recycled water capacity, and resulted in recommendations for expanding process alternatives from the Plan to accommodate additional flows and loadings. This report does not evaluate alternative processes.

This report only discusses projected triggered by capacity increases needed to accommodate growth. Refer to the Plan for information about projects that are triggered by factors that are not related to capacity increases, including:

- Possible future regulatory changes to lower ammonia limits.
- Equipment redundancy for risk mitigation and maintenance purposes.
- Improvements to upgrade aging facilities to address equipment wear or deterioration.
- Improvements to enhance operations.
- District acceptance of fats, oils and grease (FOG); and winery wastes at the WWTP (added to either or both the solids systems and oxidation ponds)

3.1 Capacity Triggers with Napa Pipe Development

Five potential project triggers from the Plan are capacity triggers:

- Peak hour wet weather flow (PHWWF) capacity deficiencies.
- Increased influent biochemical oxygen demand (BOD) loading.
- Increased influent total suspended solids (TSS) loading.
- Increased WWTP influent flows.
- Increased recycled water demand.

For this report, trigger charts from the Plan were revised to include the expanded Napa Pipe development. To establish a set of trigger dates, the expanded Napa Pipe development was assumed to occur evenly throughout the planning period, and was added to the projected District growth from the Plan. If growth is delayed, the District would reach identified triggers at later dates. Conversely, if growth occurs earlier than projected, capacity triggers would be reached earlier. In addition, increasing wastewater strength without growth could also trigger projects earlier. If growth occurs significantly faster than anticipated on the trigger charts, the flow and loading triggers should be re-evaluated to ensure that projects are completed in time.

3.1.1 PHWWF Trigger

The influent pump station (IPS) limits WWTP PHWWF capacity. The projected PHWWF to the WWTP is based on un-attenuated flow, which represents the total instantaneous flow in the collection system that would arrive at the WWTP if there were no attenuation, storage or hydraulic limitations. Un-attenuated flows are not projected to increase substantially with the expanded Napa Pipe development (from 89.9 million gallons per day [mgd] to 90.2 mgd); however, the collection system has conveyance capacity constraints that limit the peak flow received at the WWTP. With these collection system constraints, the immediate firm IPS capacity requirement remains at 60 mgd. After the collection system is upgraded to address capacity deficiencies, the firm capacity might need to be increased to pump at up to 90 mgd; however, if the District's infiltration and inflow (I/I) reduction efforts prove to be successful, the PWWF at the WWTP would be something less than 90 mgd. For this project, a PWWF of 60 mgd is assumed, with provisions for expansion to 90 mgd. Since the expansion beyond 60 mgd depends mainly on collection system upgrades and I/I reduction and not on growth, this report presents no trigger chart.

The existing IPS has a reliable (firm) capacity with the largest pump out of service of 25 mgd, significantly less than current peak flows of 60 mgd. Together, the downstream facilities (the headworks and the diversion pipeline to the ponds) have the capacity to convey projected PHWWF. The Plan recommended IPS expansion to 60 mgd on an accelerated schedule, with further monitoring of PHWWF and an additional IPS expansion if attenuated PHWWF increases beyond 60 mgd.

3.1.2 BOD Loading Trigger

The combined pond and activated sludge capacity limits the WWTP BOD capacity. During master planning, several BOD loading scenarios were analyzed during the capacity and alternatives analysis, including average dry weather maximum month BOD loading and average wet weather maximum month (AWWMM) BOD loading. AWWMM BOD loading (the running 30-day average of BOD loading) was found to be the limiting parameter. AWWMM BOD loading was converted to average annual (AA) BOD loading using the loading relationships shown in Table 2-3.

As shown in Figure 3-1, BOD loading triggers projects in different areas of the WWTP over the planning period. Projects are triggered up to one year earlier with the expanded Napa Pipe development included, and an additional pond aerator project is required. The District should monitor AA BOD loading and trigger new projects based on Figure 3-1.

3.1.3 River Discharge Flow Triggers

Flocculating clarifier, activated sludge, Pond 4 pump station, and pond water direct filtration capacities limit the river discharge flow. Analyses also considered secondary effluent pumping and chlorine contact capacity and hydraulics. To control pond levels during wet weather, the required river discharge capacity during wet weather was set to equal the AWWMM flow. Thus, whatever wastewater entered the WWTP would be treated and discharged. AWWMM flow was converted to average dry weather flow (ADWF) using the relationships shown in Table 2-3. Available river discharge flow is also shown for low influent flows when the activated sludge flow is limited. Based on water balance results, these river discharge capacities are sufficient.

As shown in Figure 3-2, river discharge flow capacity triggers projects throughout the WWTP. Projects are triggered up to one year earlier with the expanded Napa Pipe development included; the Phase 2 filter project is needed by 2029 for river discharge capacity. Without the expanded Napa Pipe development, Phase 2 filters are not needed for river discharge during the planning period. Recycled water demand may trigger the Phase 2 filters before river discharge flows would trigger their construction. A minor modification to the Plan is that the chlorine contact tank adjustable weir gate (part of the Phase 1 filter project) should be designed to accommodate a maximum river discharge flow of 26 mgd instead of the previously recommended 25.1 mgd.

3.1.4 Recycled Water Demand Triggers

Several processes, including filtration capacity, disinfection capacity, and available secondary effluent flows, limit recycled water production capacity. Projected recycled water demands are not related to the growth-based influent flow and loading projections, but depend on District addition of recycled water customers. The exact timing of the recycled water demand increases is beyond the scope of this report; therefore, the chart shown in Figure 3-3 does not show project timing, but illustrates the total capacity after each project.

Figure 3-3 also shows the peak recycled water demands with the ponds empty on May 1 and full on May 1, as determined using the water balance model. Phase 1 filters are necessary to meet the demands with ponds empty on May 1 (median yearly supply of 3,000 AF with the expanded Napa Pipe development flows and required filter production capacity of 8.5 mgd). Phase 2 filters are necessary to accommodate the demands with ponds full on May 1 (median yearly supply of 4,600 AF with the expanded Napa Pipe development flows and required filter production capacity of 14.0 mgd).

3.1.5 Solids Handling Demands

Digestion capacity limits solids handling capacity. Projected sludge loadings are shown based on influent flow and loading projections. Projected sludge loadings include both primary and waste activated sludge based on process modeling results. Since primary sludge accounts for more than 60 percent of the projected sludge loading, an approximate relationship to AA TSS loading is shown as the trigger for digester expansion. Projected sludge loadings do not include District acceptance of non-traditional wastes. If non-traditional wastes are accepted, digester expansion would be required sooner. Figure 3-4 shows projects triggered by AA TSS loading including the expanded Napa Pipe development. Total sludge loading is shown for reference; the WWTP Master Plan recommends that monthly digester loadings be monitored also. With the expanded Napa Pipe development, digester expansion is triggered one year earlier.

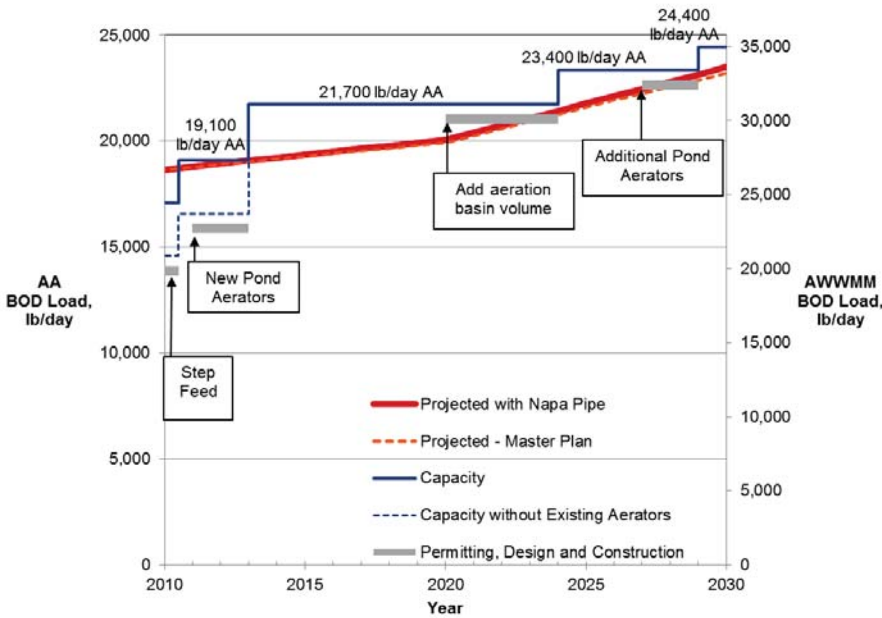

Figure 3-1. BOD Loading Triggers

AA BOD load increases trigger projects. Dates shown represent projections. Napa Pipe development was evenly distributed throughout the planning period.

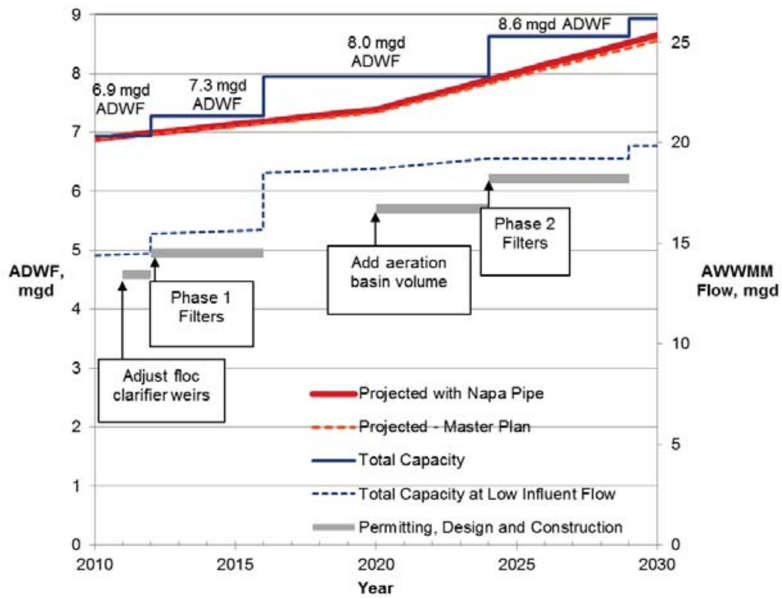

Figure 3-2. River Discharge Flow Triggers

ADWF increases trigger projects. Required river discharge flow is assumed to equal AWWMMF to maintain pond levels during a maximum month influent flow. Dates shown represent projections. Napa Pipe development was evenly distributed throughout the planning period.

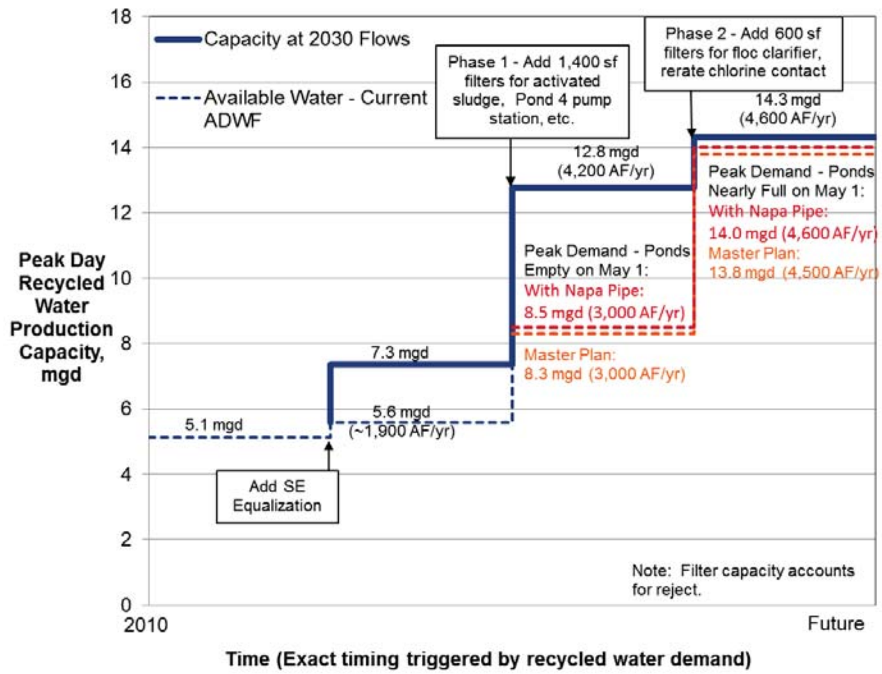

Figure 3-3. Recycled Water Project Capacities

Recycled water from activated sludge is limited to the ADWF into the WWTP.
Available water for current ADWF shows potential recycled water production with current ADWF.
Capacity shows the installed capacity, which is equivalent to the available water at the 2030 ADWF.

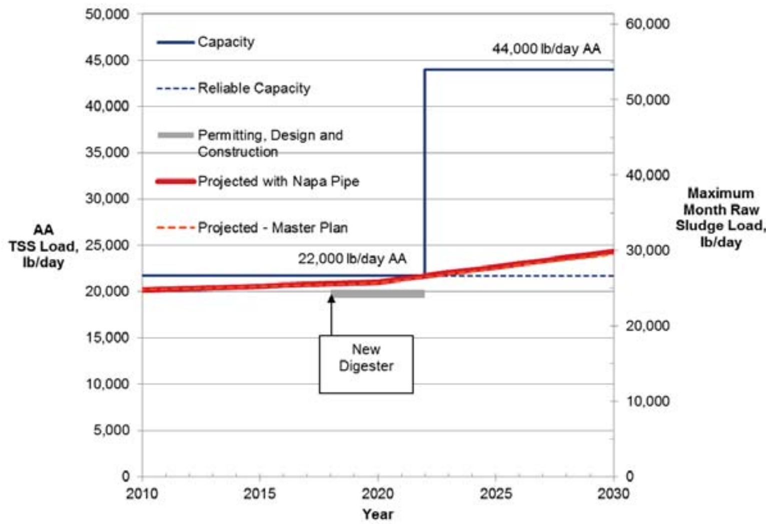

Figure 3-4. Solids Handling Triggers

AA TSS loading triggers projects. AA TSS loading does not include non-traditional wastes.
Monitoring monthly raw sludge load to the digester is recommended. Dates shown represent projections.
Napa Pipe development was evenly distributed throughout the planning period.

3.2 Recommended Projects

This section describes the recommended projects and includes project triggers and implementation time. Table 3-1 summarizes the expansion needs to accommodate expanded Napa Pipe flows by process area. Project descriptions with modifications from the WWTP Master Plan follow.

Table 3-1. Process Expansion Needs for Napa Pipe

Process Area	Capacity Expansion in Master Plan[1]	Further Expansion for Napa Pipe[2]
Influent Pumping	Expand IPS to 60 mgd peak flow, with provisions to expand to 90 mgd	No modification
Headworks	Relieve hydraulic bottlenecks to achieve 20 mgd peak flow capacity	No modification
Primary Treatment	Relieve hydraulic bottlenecks to achieve 20 mgd peak flow capacity	No modification
Activated Sludge	Add 0.66- million gallons (MG) aeration tank	No modification
Pond Aeration	Replace existing aerators and add additional 125-hp of aeration	Add 50-hp of aeration, beyond that already in the Master Plan
Pond 4 Pump Station	Rehabilitate and expand to 12 mgd firm capacity	No modification
Flocculating Clarifiers	Adjust flocculating clarifier weirs to achieve 8.5 mgd hydraulic capacity	No modification
Secondary Effluent Equalization	Add secondary effluent equalization	No modification
Filters	Add 1,400 sf of filters for activated sludge effluent (Phase 1). Add 600 sf of filters (Phase 2) if needed to meet recycled water demand	Phase 2 filters needed for river discharge capacity
Chlorination	Add chlorine injection and mixing system for west chlorine contact basin. Add adjustable chlorine contact tank weir gate to relieve peak hydraulic limitations. Perform contact basin tracer/re-rating study.	Design adjustable weir gate to accommodate flows up to 26 mgd
DAFT and TWAS Pumping	No modification.	No modification
Anaerobic Digestion	Convert existing half-egg digester to a complete digester. Construct new sludge and gas storage tanks.	No modification
BFP Dewatering and Feed Pumping	No modification.	No modification

Notes:

[1]From WWTP Master Plan, April 2011, Brown and Caldwell and Carollo Engineers. Does not include projects that are condition/age related.

[2]Total flow and loading resulting from the proposed Napa Pipe development.

3.2.1 Aeration Basin Expansion

The aeration basin project is the same as in the Plan, including a new 0.66-MG aeration tank, and modified primary effluent and return activated sludge (RAS) piping and distribution. As in the Plan, up to 40 months are required for design and construction.

The triggers for the project are modified slightly with the increased growth due to the expanded Napa Pipe development. The new aeration basin needs to be on line to accommodate loading increases when AA BOD loading exceeds about 21,700 pounds per day (lb/day) (projected to occur in 2024) or when ADWF exceeds 8.0 mgd to accommodate river discharge capacity requirements (approximately 2024). Thus, the District should track both ADWF and AA BOD loading and their growth trends, since either parameter could trigger the project if future flows and loadings differ from current projections.

For the aeration basin to be in service when the capacity is required, design should begin either when AA BOD loading reaches about 20,000 lb/day or when ADWF reaches about 7.4 mgd.

3.2.2 Increase Pond Aeration (50-hp)

The Plan included a project to increase pond aeration by 125-horsepower (hp). To accommodate the expanded Napa Pipe development, a second pond aeration project with an additional 50-hp of aeration to the ponds is required to increase BOD loading capacity.

After the 50-hp of pond aerators are installed (assuming the original 125-hp aerators and the aeration basin expansion are in service), the WWTP will have an AA BOD loading capacity of 24,400 lb/day.

The pond aeration project will require up to 23 months for permitting, design and construction, including:

- Three months for predesign.
- Five months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Nine months for construction and commissioning.

BOD loading capacity triggers this project. Based on current loading projections, the new aerators need to be on line when AA BOD loading exceeds about 23,400 lb/day (2029). Design should begin when AA BOD loading reaches about 22,400 lb/day.

3.2.3 Phase 1 Recycled Water Expansion

The Phase 1 Recycled Water Expansion project (already underway) should be modified so that the chlorine contact tank adjustable weir gate can accommodate 26 mgd during river discharge. Contact time is sufficient at this flow. All other aspects of the Phase 1 Recycled Water Expansion project (project components, triggers, timing and cost) remain the same.

3.2.4 Phase 2 Recycled Water Expansion

The Phase 2 Recycled Water Expansion is the same as in the Plan and includes 600 square feet of filters and a chlorine contact basin tracer/re-rating study. As in the Plan, up to 38 months are required for design and construction.

Analyses have identified two potential triggers for this project—recycled water demand and required river discharge. The project needs to be online when peak day recycled water demands exceed the Phase 1 Recycled Water Expansion project capacity. This project should be considered when peak day recycled water demands exceed 10.8 mgd.

With the increased flow from the expanded Napa Pipe development, the Phase 2 filters are now also used to increase river discharge capacity (triggered by ADWF of 8.0 mgd). The Plan showed this project as unscheduled. With the increased river discharge needs for the expanded Napa Pipe development, the project now has a defined completion date.

3.2.5 Complete Egg-shaped Digester

The egg-shaped digester project is the same as in the Plan and includes converting the existing half-egg digester to a complete digester, and adding sludge and gas storage tanks. As in the Plan, up to 46 months are required for design and construction.

Project triggers are modified slightly with the increased growth due to the expanded Napa Pipe development. Digester solids loading capacity triggers this project. Based on current loading projections, the new digester needs to be on line when digester solids loading exceeds about 27,000 lb/day (AA influent TSS loading of about 22,000 lb/day, assuming only primary and waste activated sludge). Design should begin when digester solids loading reaches about 24,700 lb/day (AA influent TSS loading of about 20,600 lb/day).

3.3 Capital Costs

Table 3-2 summarizes the capital costs and implementation details for the revised project to accommodate Napa Pipe development. Cells highlighted in blue are different than those in the Plan. Note that none of the costs have been adjusted upward to reflect inflation that has occurred since April 2010 when the Plan cost estimates were prepared.

Table 3-2. Project Implementation Summary with the Expanded Napa Pipe Development

Project	Capital Cost Million $[1]	Trigger to Begin Predesign	Permitting, Design and Construction Duration, months	Priority[2]	Project Completion Date
Flocculating Clarifier Weirs	0.6	ADWF of 6.8 mgd (2011)	10	A	2012
Full-Scale Testing of Flocculating Clarifier Effluent to Activated Sludge	0.3	Peak day recycled water demand of 5.1 mgd and Phase 1 Recycled Water Expansion not on-line	NA	A	2012[3]
Purchase Spare Digester Mixer	0.4	Redundancy – start in 2011	10	A	2012
Increase Pond Aeration (Add 125 hp)	2.2	AA BOD loading of 18,700 lb/day (2011)	23	A	2013
Recycled Water Jockey Pump	0.2	Reduce maintenance - immediate (2011)	24	A	2013
Activated Sludge Diffuser Replacement	0.9	Condition/age - start in 2011 based on useful life of existing equipment	25	C	2013
Pond Improvements – Phase 1	0.1	Condition/age - immediate (2011)	25	C	2013[4]
Pond Improvements – Phase 2	2.8	Condition/age - immediate (2011)	25	A	2013[5]
Tertiary Treatment Improvements	1.1	Condition/operational enhancements - immediate (2011)	24	C	2013
3W System Improvements	0.3	Condition/operational enhancement - immediate (2011)	24	C	2013
Solids Handling Improvements	0.8	Operational enhancements – immediate (2011)	31	C	2014
IPS Expansion	15.5	PHWWF of 25.0 mgd (2011)	48	A	2015
Phase 1 Recycled Water Expansion	13.9	Four years before peak day recycled water demand exceeds 5.1 mgd (2011) or ADWF of 7.0 mgd (2012)	50	A	2015
Line Recycled Water Reservoir	0.2	Recycled water storage needs	23	C	2015
Headworks Improvements	1.2	Condition/age - start in 2014 based on useful life of existing equipment	25	C	2016
Primary Treatment Improvements	0.3	Operational enhancements. Start in 2014 in parallel with Headworks Improvements.	22	C	2016
Complete Egg-Shaped Digester	11.4	Maximum month sludge loading of 24,700 lb/day (approximately AA influent TSS loading of 20,600 lb/day) (2018)	46	B	2022
Aeration Basin Expansion	4.2	AA BOD loading of 20,000 lb/day (2020) or ADWF of 7.4 (2020)	40	B	2024
Phase 2 Recycled Water Expansion	4.9	Four years before peak day recycled water demand exceeds 11.1 mgd or ADWF of 8.0 (2025)	38	B	2029
Increase Pond Aeration (Add 50 hp)	0.9	AA BOD loading of 22,400 lb/day (2027)	23	B	2029
Base Project Total	**62.2**				

[1]Costs were determined for April 2010 for Napa, California, using the San Francisco ENRCCI (ENR construction cost index) of 9,730.
[2]Priority A indicates projects required to accommodate capacity by 2016, projects critical for reliability of WWTP operations, and projects expected to save significant maintenance cost. Priority B projects accommodate capacity increases after 2016. Priority C projects are mainly facilities condition/age related.
[3]Testing will take approximately one year, so results could be available by 2012.
[4]Install transfer structures between Ponds 1 and 2.
[5]Install replacement aerators, remaining transfer structures and distribution piping. The District may choose to delay some parts of this project, to reduce early expenditures. Aerator replacement is most important.

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Section 4

Limitations

This document was prepared solely for Napa Sanitation District in accordance with professional standards at the time the services were performed and in accordance with the contract between Napa Sanitation District and Brown and Caldwell dated October 11, 2013. This document is governed by the specific scope of work authorized by Napa Sanitation District; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Napa Sanitation District and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 5

References

Brown and Caldwell and Carollo Engineers, Napa Sanitation District Wastewater Treatment Plant Master Plan, April 2011.

City of Napa, City of Napa General Plan Policy Document, Envision Napa 2020, amended August 12, 2003.

GHD, Napa Pipe Collection System Impact Analysis, Memorandum, October 25, 2013.

Larry Walker Associates, Strategic Plan for Recycled Water Use for 2020, August 2005.

Napa County, Napa County General Plan, amended March 5, 2002.

Winzler & Kelly, Collection System Master Plan, October 2007.

Winzler & Kelly, Napa Sanitation District, Technical Memorandum, Influent Pump Station (IPS) Seismic Study and Replacement, May 2009.

Winzler & Kelly, Napa Sanitation District, Technical Memorandum No. 1, Napa Pipe Collection System Impact Analysis, July 21, 2011.

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Appendix A: Water Balance Supporting Information

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Table A-1. Water Balance Results and Input Summary

Condition	Current ADWF, Ponds at Minimum Level on May 1	2030 ADWF, Ponds at Minimum Level on May 1	2030 ADWF with Napa Pipe, Ponds at Minimum Level on May 1	Incremental Increase between 2030 ADWF and 2030 ADWF with Napa Pipe Development, Ponds at Minimum Level on May 1[1]	Current ADWF, Ponds Nearly Full on May 1	2030 ADWF, Ponds Nearly Full on May 1	2030 ADWF with Napa Pipe, Ponds Nearly Full on May 1	Incremental Increase between 2030 ADWF and 2030 ADWF with Napa Pipe Development, Ponds Nearly Full on May 1[1]
Key Results								
Median Yearly Water Demand, AF [2]	2,323	2,955	3,007	52	3,658	4,518	4,570	52
Dry Year Water Demand, AF [3]	2,636	3,358	3,417	60	4,162	5,145	5,205	60
Peak Demand, mgd [4]	6.1	8.3	8.5	0.2	10.8	13.8	14.0	0.2
Return Frequency for Summer Emergency Discharge, yr [5]	52.0	7.4	7.4	NA	13.0	2.0	2.0	NA
Return frequency for Recycled Water Deficit, yr [6]	10.4	10.4	10.4	NA	10.4	10.4	10.4	NA
Return frequency for Winter Overflow, yr [7]	52	52	52	NA	52	52	52	NA
Model Inputs								
ADWF Condition	Current	2030	Napa Pipe	NA	Current	2030	Napa Pipe	NA
Vineyard Acres	455	2,500	2,700	200	5,200	8,500	8,700	200
Turf Acres	1,200	1,254	1,254	0	1,254	1,254	1,254	0
NSD Controlled Acres	480	480	480	0	480	480	480	0
NSD Land, Percent of Theoretical	0% – 66%	0% – 66%	0% – 66%	NA	0% – 66%	0% – 66%	0% – 66%	NA
NSD Land Recycled Water Demand, AF	0 – 808	0 – 808	0 – 808	0	0 – 808	0 – 808	0 – 808	0
Off-Season Demand, AF	0	0	0	NA	0	0	0	NA
March 1 Pond Volume Goal, MG [8]	0	0	0	NA	300	320	310	NA
April 1 Pond Volume Goal, MG [8]	0	0	0	NA	400	470	470	NA
May 1 Pond Volume Goal, MG [8]	0	0	0	NA	430	540	540	NA
Floc Clarifier Capacity Condition for River Discharge	Current	Weirs Fixed	Weirs Fixed	NA	Current	Weirs Fixed	Weirs Fixed	NA
Filter Condition for River Discharge	Current	Phase 1	Phase 1	NA	Current	Phase 1	Phase 1	NA
Activated Sludge Condition for River Discharge	Current	Expanded	Expanded	NA	Current	Expanded	Expanded	NA

[1]The WWTP Master Plan included limited development on the Napa Pipe Site. The incremental increase shows the change due to the proposed Napa Pipe development that is not included in the Master Plan.
[2]Does not include District controlled land, but does include District land used in the future for golf courses or vineyards. During dry years, District controlled land is assumed not to be irrigated. During wet years, District controlled land is irrigated to minimize summer emergency discharge. Median District land demands were 800 AF per year.
[3]Dry years are based on a 10-year return frequency for protected shortfalls in deliveries, so District can supply sufficient water to meet user demands nine out of 10 years. In other words, the District has to limit or reduce deliveries about one in 10 years.
[4]Peak demand based on the peak 30-day demand from the model for the 10-year return frequency dry year, without any delivery curtailment. Further delivery curtailment may be required during peak week demand conditions.
[5]Assumes District controlled land irrigated during wet years.
[6]Assumes District controlled land not irrigated during dry years.
[7]Assumes District controlled land is irrigated.
[8]May 1 pond storage objective was set to store as much water as possible while preventing pond overflow in March and April during wet years. When ponds are nearly full on May 1, emergency discharge is frequently necessary in May. March 1 and April 1 pond storage objective set to ensure recycled water available to users during dry years. Ponds fill slowly in March and April, but faster in January and February.
Note: A minor update to model affecting river discharge flow in August 2011 resulted in insignificant differences in some values compared to the Master Plan version.

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Table A-2. Recycled Water Demand by Crop Type			
Condition	Vineyard	Turf	NSD Land
Median Annual Water Demand, ft/yr	0.26	1.84	0.00 – 1.68
Minimum Annual Water Demand, ft/yr	0.19	1.35	0.00 – 1.25

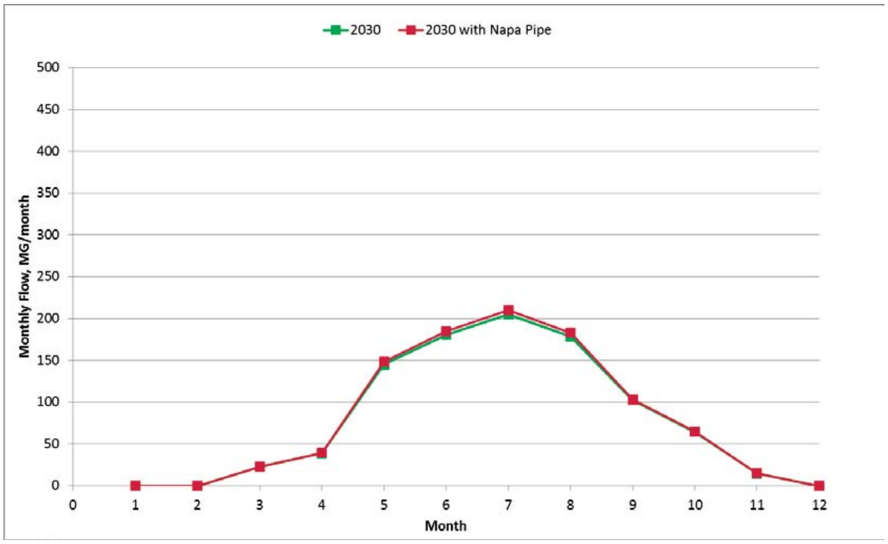

Figure A1. Median Recycled Water Demand with Ponds Empty on May 1

Does not include District Land.

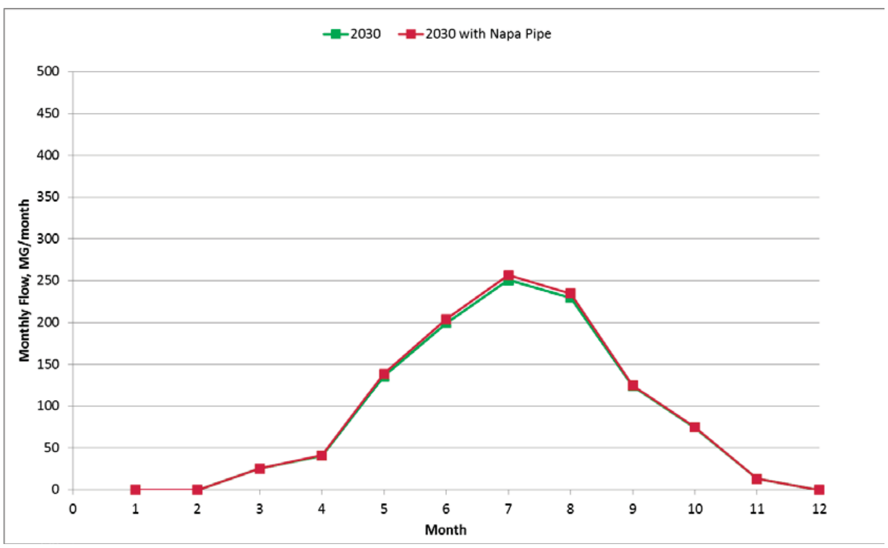

Figure A2. Dry Year Recycled Water Demand with Ponds Empty on May 1

Does not include District Land. Dry year is based on a 10-year return frequency.

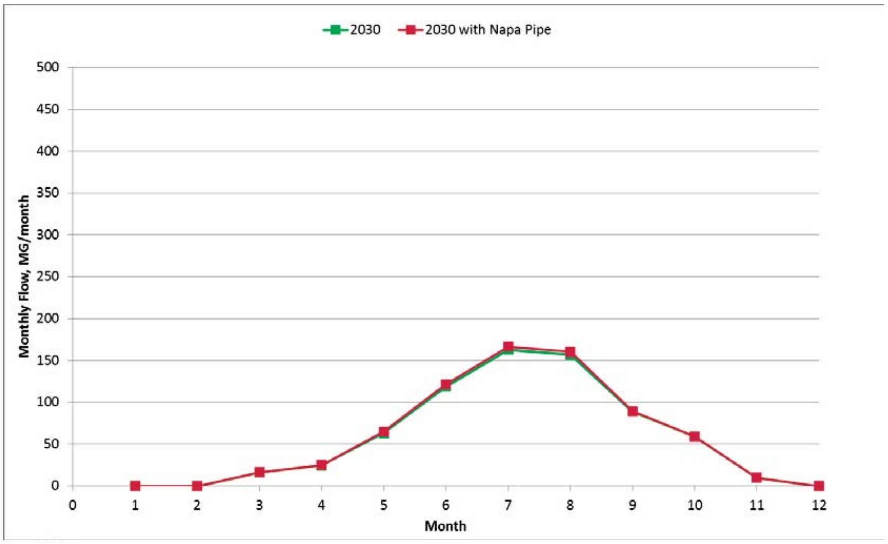

Figure A3. Wet Year Recycled Water Demand with Ponds Empty on May 1

Does not include District Land. Wet year is based on the wettest year in the record.

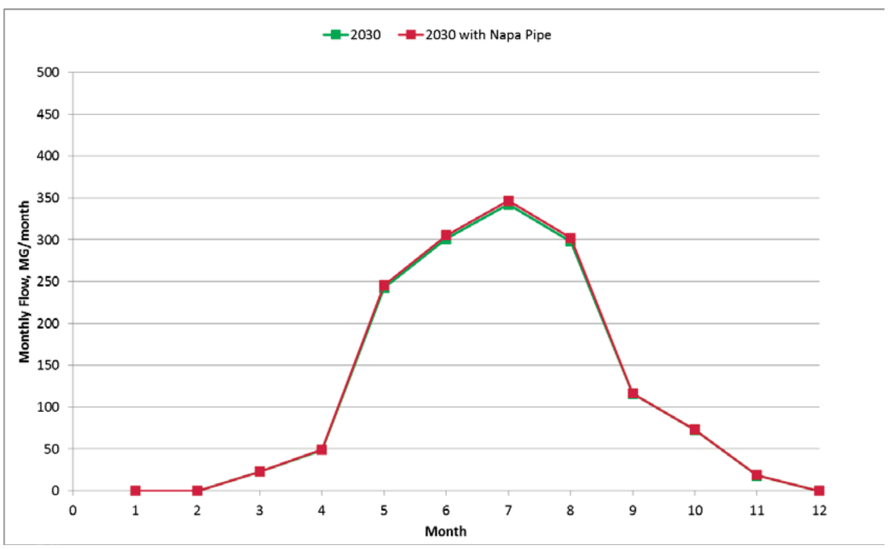

Figure A4. Median Recycled Water Demand with Ponds Nearly Full on May 1

Does not include District Land.

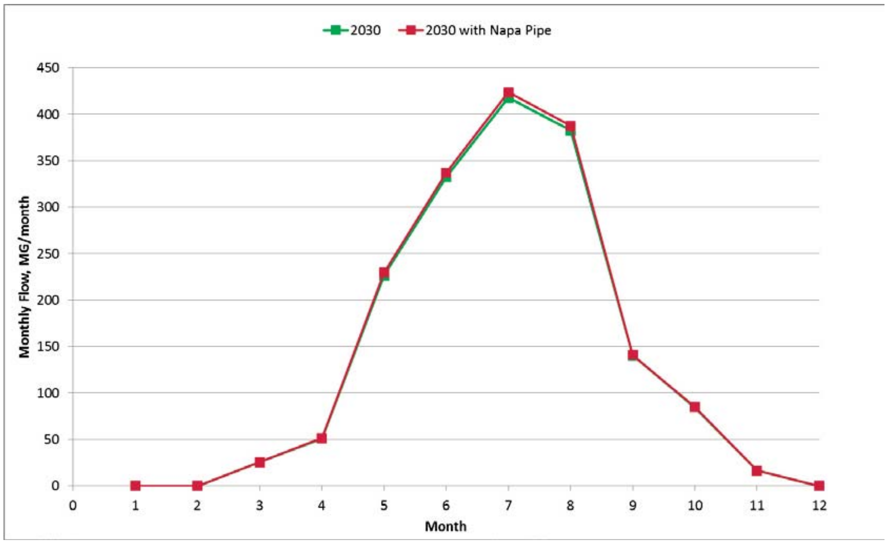

Figure A5. Dry Year Recycled Water Demand with Ponds Nearly Full on May 1

Does not include District Land. Dry year is based on a 10-year return frequency.

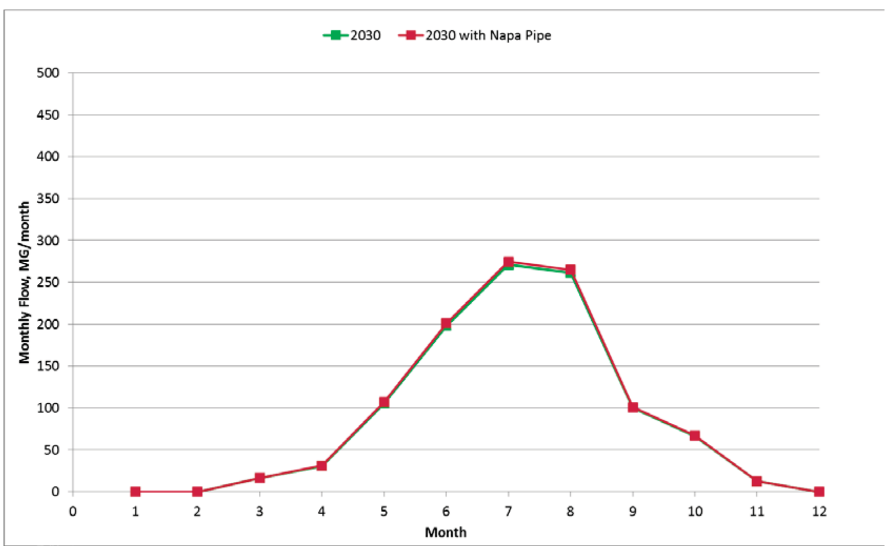

Figure A6. Wet Year Recycled Water Demand with Ponds Nearly Full on May 1

Does not include District Land. Wet year is based on the wettest year in the record.

Appendix B: WWTP Impacts Supporting Information

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Table B-1. Design Criteria

Parameter	2030 – Master Plan	2030 with Napa Pipe
New Aeration Basin		
Number of basins	1	1
Number of compartments per basin	1	1
Side water depth, feet	19	19
Size of basin, feet	133 x 35	133 x 35
Size of compartments 1 through 5, each, ft		
Size of compartment 6, feet		
Unaerated volume (anaerobic/anoxic), MG	0.33	0.33
Aerated volume, MG	0.33	0.33
Total new aeration basin volume, MG	0.66	0.66
Total Aeration Basins		
Unaerated volume (anaerobic/anoxic), MG	0.51	0.51
Aerated volume, MG	2.36	2.36
Total volume, MG	2.88	2.88
Aerated fraction, %	82.3	82.3
Facultative Ponds		
New aerators, hp	125	175
Total aerators, hp	225	275
Secondary Effluent Equalization Basin		
Type	lined basin	lined basin
Number	2	2
Volume, each, gal	650,000	650,000
Maximum water depth, feet	10	10
Secondary Effluent Equalization Pump Station		
Number of pumps	2 + 1	2 + 1
Capacity, each, mgd	4	4
Firm capacity, mgd	8	8
Phase 1 Filters		
Total flocculation/filter conditioning volume, gal	18,225	18,225
Filter Type	continuous backwash	continuous backwash
Number of filters	2	2
Area, per filter, sq ft	700	700
Total area, sq ft	1,400	1,400
Phase 2 Filters		
Filter Type	continuous backwash	continuous backwash
Total area, sq ft	600	600

Table B-2. ADWMM Flow and Loadings

Parameter	2030-Master Plan	2030 with Napa Pipe
Influent		
Flow, mgd	9.4	9.5
BOD Loading, lb/day	27,200	27,600
NH3-N Loading, lb/day	3,020	3,050
Influent Directed to Facultative Ponds		
Flow, mgd	0	0.0
BOD Loading, lb/day	0	0
NH3-N Loading, lb/day	0	0
Primary Clarifier Influent		
Flow, mgd	9.4	9.5
BOD Loading, lb/day	27,200	27,600
NH3-N Loading, lb/day	3,020	3,050
Primary Clarifier Effluent (including DAFT overflow)		
Average flow, mgd	9.6	9.7
Maximum flow, mgd	15.95	16.50
BOD Loading, lb/day	15,900	16,200
NH3-N Loading, lb/day	3,020	3,050
TSS Removal, percent	64%	64%
BOD Removal, percent	42%	41%
Average Overflow Rate, gpd/sf	950	960
Peak Overflow Rate, gpd/sf	1,590	1,640
Facultative Pond Influent		
Flow from Influent, mgd	0.0	0.0
Flow from Primary Effluent, mgd	0.9	1.0
Flow from sidestreams, mgd	2.8	2.8
BOD Loading, lb/day	2,200	2,300
NH3-N Loading, lb/day	1,400	1,500
BOD Loading Capacity Without Aeration, lb/day	8,900	8,900
BOD Loading Treated by Aerators, lb/day	0	0
Activated Sludge		
Influent Flow, mgd (includes filtrate and/or algae sludge where applicable)	8.7	8.7
BOD Loading, lb/day	14,400	14,600
NH3-N Loading, lb/day	2,700	2,700
Total Solids Retention Time, days		
Maximum MLSS, mg/L		
Average Secondary Clarifier Surface Overflow Rate, gpd/sf	550	560

Table B-2. ADWMM Flow and Loadings

Parameter	2030-Master Plan	2030 with Napa Pipe
RAS Percent		
Algae Removal		
Pond 4 Pump Station Flow, mgd	4.2	4.2
Flocculating Clarifiers		
Flow, mgd	4.2	4.2
Algae sludge flow, mgd	0.6	0.6
Tertiary Filtration (reclamation only)		
Flocculating Clarifier Effluent (existing filters)		
Flow, mgd	3.6	3.6
Reject, mgd	1.2	1.2
Maximum Loading Rate, gpd/sf	2.2	2.2
Maximum Loading, mgd	6.3	6.3
Activated Sludge Effluent (new filters)		
Flow, mgd	8.5	8.5
Reject, mgd	0.8	0.8
Maximum Loading Rate, gpd/sf	4.2	4.2
Maximum Loading, mgd	8.5	8.5
Effluent Flows		
Recycled Water		
Installed Capacity, mgd	12.8	12.8
Secondary Effluent and Flocculating Clarifier Effluent Available for Recycled Water, accounting for reject), mgd	13.9	14.0
River Discharge		
Maximum month flow at peak influent flow, mgd		
Solids Handling		
Primary Sludge, lb/d	20,400	20,600
WAS, lb/day	9,200	9,300

ADWMM is average dry weather maximum month.

Table B-3. AWWMM Flow and Loadings

Parameter	2030-Master Plan	2030 with Napa Pipe
Influent		
Flow, mgd	17.6	17.8
BOD Loading, lb/day	33,200	33,600
NH3-N Loading, lb/day	3,020	3,050
Influent Directed to Facultative Ponds		
Flow, mgd	1.2	1.3
BOD Loading, lb/day	2,200	2,300
NH3-N Loading, lb/day	180	190
Primary Clarifier Influent		
Flow, mgd	16.3	16.5
BOD Loading, lb/day	31,000	31,300
NH3-N Loading, lb/day	2,840	2,860
Primary Clarifier Effluent (including DAFT overflow)		
Average flow, mgd	16.5	16.6
Maximum flow, mgd	20.00	20.00
BOD Loading, lb/day	22,000	22,200
NH3-N Loading, lb/day	2,840	2,860
TSS Removal, percent	40%	41%
BOD Removal, percent	29%	29%
Average Overflow Rate, gpd/sf	1,640	1,650
Peak Overflow Rate, gpd/sf	1,990	1,990
Facultative Pond Influent		
Flow from Influent, mgd	1.2	1.3
Flow from Primary Effluent, mgd	6.3	6.4
Flow from sidestreams, mgd	2.9	2.9
BOD Loading, lb/day	11,400	11,700
NH3-N Loading, lb/day	2,700	2,800
BOD Loading Capacity Without Aeration, lb/day	7,400	7,400
BOD Loading Treated by Aerators, lb/day	4,000	4,300

Table B-3. AWWMM Flow and Loadings		
Parameter	**2030-Master Plan**	**2030 with Napa Pipe**
Activated Sludge		
Influent Flow, mgd (includes filtrate and/or algae sludge where applicable)	10.2	10.2
BOD Loading, lb/day	13,600	13,600
NH3-N Loading, lb/day	1,800	1,800
Total Solids Retention Time, days		
Maximum MLSS, mg/L		
Average Secondary Clarifier Surface Overflow Rate, gpd/sf	650	650
RAS Percent		
Algae Removal		
Pond 4 Pump Station Flow, mgd	16.0	16.0
Flocculating Clarifiers		
Flow, mgd	9.2	9.2
Algae sludge flow, mgd	0.7	0.7
Direct Filtration (winter only)		
Flow, mgd	6.9	6.9
Reject, mgd	2.0	2.0
Maximum Loading Rate, gpd/sf	1.4	1.4
Maximum Loading, mgd	6.9	6.9
Effluent Flows		
River Discharge		
Maximum month flow at peak influent flow, mgd	25.3	25.3
Solids Handling		
Primary Sludge, lb/d	14,900	15,400
WAS, lb/day	8,700	8,700

AWWMM is average wet weather maximum month.

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Prepared by

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SANITATION MITIGATIONS

Exhibit F.3 Addendum to Recycled to Water Impact Analysis

Napa Pipe
Addendum to
Recycled Water Impact Analysis

Prepared for Napa Redevelopment Partners

March 27, 2014

RMC
Water and Environment

Table of Contents

1 Background and Purpose

The purpose of this addendum to the *Napa Pipe Recycled Water Impact Analysis* is to update, the evaluation of impacts to the Napa Sanitation District's (District's) recycled water system and required mitigation measures related to incremental wastewater flows from the proposed Napa Pipe Development greater than those anticipated in the District's recent master planning process.

This study is based on Napa County's most recent changes for the Napa Pipe development (Development) as indicated in the *Napa Pipe Development Plan-Draft* (August 2013), which includes 700 dwelling units of mixed type or 945 dwelling units with state density bonuses, 10,000 square feet of office use; 75,000 square feet of light industrial/R&D/warehousing uses; 40,000 square feet of retail and restaurants; a 150-unit senior housing facility; a 150-suite hotel; 34.4 acres of open space; and 154,000 square feet of Costco warehouse and gas station.

The discharge of treated wastewater from the District's Soscol Water Recycling Facility (WWTP) to the Napa River is prohibited during the dry season (May 1 through October 31), as a condition of the District's NPDES Permit No. CA0037575. During this period, a portion of the wastewater flow is treated to recycled water standards for irrigation. This recycled water use is necessary in order to prevent discharges to the Napa River from May 1 to October 31. Connection of the Development would increase wastewater flows to the WWTP. The additional dry season flows would have to be offset by an increase in the amount of recycled water delivered to customers during this time.

Recycled water delivery is currently limited by the extent of the distribution system and the existing connected customers. Additional demand for recycled water exists, but the distribution system will have to be expanded and/or new connections need to be provided to new potential customers. Continued expansion of the recycled water system and use are necessary for disposal of additional wastewater flows associated with planned growth to prevent dry season discharges.

2 Basis of Analysis/Criteria

2.1 Master Plans and Impact Analyses

Three master plans have been completed for the District to guide the sustainable management of its facilities (i.e. wastewater collection system, treatment plant, and recycled water facilities). Each of the three plans describes a distinct portion of the facilities. The *Strategic Plan for Recycled Water Use in the Year 2020* (Strategic Plan) (Larry Walker Associates, 2005) includes estimated recycled water demands for potential recycled water users throughout the service area. Landscape irrigation requirements for the proposed Napa Pipe Development were not included in the Strategic Plan, nor have they been included in subsequent planning and design work.

The other two master plans include the *Collection System Master Plan* (Winzler & Kelly, 2007) and the *Wastewater Treatment Plant Master Plan* (WWTP Master Plan) (Brown & Caldwell and Carollo, 2011). The relationship between the three plans is illustrated in **Figure 1**.

Figure 1. **Hydraulic Relationship between Master Planning Documents**

The impacts of additional flows related to the Napa Pipe Development on the District's facilities have recently also been analyzed by the authors of the respective Master Plans. For consistency, information and data (i.e. flow criteria) developed under each analysis has been fed into the next study in accordance with their hydraulic relationships.

2.2 Existing Recycled Water System

The District began providing recycled water to users in 1994. In 2012, 1,852 acre-feet of treated wastewater was recycled. Current users include vineyards, golf courses, the Napa Valley College campus, a recreational park, a cemetery, industrial parks, and corporate parks.

Under the current configuration of the recycled water system, disinfected tertiary treated water from the District's WWTP is pumped into two divergent transmission pipelines that send water toward the southeast and toward the north. Both the north branch and south branch are supplied by the Soscol Pump Station (SPS), located at the WWTP. The SPS pumps draw recycled water from the District's two recycled water storage reservoirs located adjacent to the pump station. Characteristics of the existing recycled water system are shown in **Table 1**.

Table 1. Existing Facility Criteria and Characteristics

Item	Units	Criteria	Comments
Existing Dry Season Average RW Demand	mgd	3.0	Based on 2008-2013 dry season RW delivery data [(1)].
Existing Max Day RW Demand	mgd	6.1	Based on 2008-2013 daily pump station flow data.
Existing Volume of Recycled Water Storage at WWTP	million gallons	6.5	
Soscol Distribution Pump Station			
No. of Pumps	-	3	
Pump Type	-	Vertical turbine	
Pump Flow	gpm	5,700	Design point of each pump
Total Pump Station Flow [(2)]	gpm	17,100	
RW Delivery Pressure (minimum)	psi	40	Milliken-Sarco-Tulocay (MST) Criteria
RW Delivery Schedule during max day	hours per day	18	MST Criteria. Uniform flow over delivery period.

Notes:

1. This demand does not include irrigation of District-owned land.
2. Total pump station flow was estimated to be 17,100 gpm by multiplying the design capacity of 5,700 gpm by the total number of pumps. The actual capacity of the pump station may vary depending on the hydraulic characteristics of the recycled water distribution system and operating criteria.

2.3 Recycled Water Planning

The District has made commitments to supply recycled water to several interested parties pending connection to the distribution system. Current recycled water planning information, which includes these customers and others that are likely to pursue a connection to the system, is shown in **Table 2**.

Any expansion of the District's recycled water system must be consistent with current and probable commitments. Of the projects on this planning list, only those that were likely to provide significant offset opportunity and for which private funding had not yet been identified were included in this analysis. Potential projects were selected from this list as opportunities for offset in order of priority. In addition, offset projects must be considered in their whole, as designed to serve their ultimate purpose.

Table 2. Planning Information for Allocation of Recycled Water (Dry Season)[1]

Type of User	Actual or Estimated Commitment[2] (acre-feet per year)
Existing Uses/Commitments:	
Existing Customers in Service Area	1,400
Montalcino Golf Course (Somky)	300
Valley Gate Vineyards & Kirkland Ranch	100
MST (could be as little as 500 AF)	700
Los Carneros Water District	450
District Use (Jameson Ranch)	100
Subtotal Existing Uses/Commitments	***3,050***
Probable Commitments:	
Infill (Kennedy Park, Industrial Parks) [3]	250
Napa State Hospital	200
Stanly Ranch (St. Regis)	200
Subtotal Probable Commitments	***650***
Other Areas Being Discussed in Near-Term:	
Los Carneros Water District	1,200
Suscol Mountain Vineyards	150
Subtotal Other Possible Areas	***1,350***
Total Probable Demand	**5,050**

Notes:
1. This table reflects updates to Table 1 of the original Recycled Water Policy, as approved by the District Board of Directors, and is accessible on the District's website.
2. Contract allocations for recycled water for individual users may be higher than the average demand projections presented later in this report to provide certainty that commitments can be honored.
3. Estimated "Infill" commitments do not include Napa Pipe proposed recycled water use.

2.4 Water Balance

A water balance was prepared as part of the WWTP Master Plan. An updated water balance for build-out (2030) conditions with and without Napa Pipe is included in the *Napa Pipe Wastewater Treatment Plant Impact Analysis Addendum* (WWTP Impact Analysis) (Brown & Caldwell, 2014).

The water balance indicates that recycled water use varies with hydrologic and climate conditions. For the purposes of this study, median values from the water balance were used to determine the level of recycled water use necessary to offset Development flows. The WWTP Impact Analysis documented the median yearly recycled water demand for 2030 with and without flows from Napa Pipe. The difference between these median yearly demands is the Development impact that must be mitigated, as shown in **Table 3**.

Table 3. Incremental Recycled Water Use Required to Offset Development Wastewater Flows

Item	Units	Criteria	Comment
Required Median Yearly Water Demand with Napa Pipe	AF	4,570	2030 ADWF with Napa Pipe
Required Median Yearly Water Demand Previously Anticipated in Master Plan	AF	4,518	2030 ADWF from WWTP Master Plan
Additional Median Yearly Water Demand Needed to Offset Napa Pipe	**AF**	**52**	

Source: *Napa Pipe Wastewater Treatment Plant Impact Analysis Addendum*, Brown & Caldwell, January 2014.

2.5 Estimating Recycled Water Demand

Estimated recycled water demands for future customers were determined by applying an irrigation requirement (unit demand factor) by crop type (in acre-feet per acre) to the number of acres of each crop to be irrigated at each site.

Estimated unit demand factors for turf and vineyard irrigation were identified in both the Strategic Plan and the WWTP Master Plan.

The Strategic Plan includes average unit demand factors for turf and vineyard irrigation that were based on reference crop evapotranspiration (ET_0) values, monthly crop coefficient (K_c) values, a recommended vineyard irrigation strategy from the University of California Cooperative Extension and actual irrigation records from the Napa Municipal Golf Course.

Irrigation requirements included in the WWTP Master Plan were based on ET_0 values and K_c values, and calibrated to more closely reflect the actual 2004 – 2009 recycled water use of two of the District's existing customers and the total flow leaving the WWTP. Although general acreages of turf/landscaping and vineyard irrigation were available for the customers identified in the WWTP Master Plan, no work was done to verify specific areas of irrigation or planting types, as this analysis was not the focus of the WWTP master planning effort. Minimum and median annual estimated irrigation requirements were provided in the WWTP Impact Analysis. Consistent with the WWTP Master Plan water balance, the median irrigation requirements were considered in this study.

In addition, a more recent analysis was conducted for the District to evaluate actual recycled water use and precipitation data to verify turf irrigation demands for customers in the District's service area. The result of this analysis and the unit demand factors selected for use in this document are shown in **Table 4**.

Table 4. Estimated Annual Irrigation Requirements

	Turf & Landscape (acre-feet/acre)	Vineyards (acre-feet/acre)
Average Demand – Strategic Plan	2.8	0.25
Median Demand – WWTP Master Plan	1.84	0.26
Average Demand – Based on Recent Actual Use and Historical Precipitation Data	2.56	N/A
Selected Unit Demand Factors	**2.56**	**0.26**

The monthly distribution of total annual recycled water demands for all Napa Sanitation District users (without Napa Pipe) anticipated for the year 2030, as provided with the WWTP Impact Analysis, is shown in **Table 5.**

Table 5. Distribution of Annual Recycled Water Demands

Units	Monthly Water Demand											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
MG/month	0	0	23	49	242	301	342	298	116	73	18	0
AF/month	0	0	71	150	743	924	1,050	916	356	22	6	0
% of total	0%	0%	2%	3%	17%	21%	23%	20%	8%	5%	1%	0%

2.6 Napa Pipe Demands and Remaining Offset

Quantity takeoff data that District staff received from Napa Pipe developers indicate that recycled water is to be used for turf/lawn, groundcover/shrubs, meadow planting, and farming at the Napa Pipe Development. The median-year estimated recycled water demands at the Development site are shown in **Table 6**.

Table 6. Napa Pipe Estimated Onsite Recycled Water Demand

Recycled Water Application Type	Area	Area	Irrigation Type [1]	Applicable Water Use Factor	Annual Demand [2]	Peak Demand [3]	Pear Hour Demand [4]
	(sq ft)	(acre)	--	(AF/acre)	(AFY)	(mgd)	(gpm)
Turf/Lawn	301,122.1	6.91	Turf and Landscape	2.56	17.7	0.043	71.3
Groundcovers/shrubs	385,333.2	8.85	Turf and Landscape	2.56	22.6	0.055	91.2
Meadow Planting	50,150.6	1.15	Native Plants	0.512	0.6	0.001	2.4
Farm Plots	60,108.5	1.38	Turf and Landscape	2.56	3.5	0.009	14.2
Total Estimated Demands (AFY):					***44***	***0.11***	***180***

Notes:

1. Native plant irrigation requirements were assumed to be 20% of turf and landscape irrigation demand values, based on irrigation requirements for low-water natives described at the website supported by Napa County and the cities and town in Napa County as follows: http://www.napa.watersavingplants.com .

2. These numbers were used for planning purposes but will ultimately depend on the actual acreage used for different application (planting) types.
3. Based on 23% of annual demand in July .
4. Assumes 10 hours of uniform irrigation to meet daily demand. This was based on the H2OMap Hydraulic Model.

The estimated demand included in this analysis is different from that included in the Napa Pipe Water and Wastewater Feasibility Study, as the unit demand factors used in this study are different than those included in the Napa Pipe Water and Wastewater Feasibility Study. July demands were estimated according to the monthly demand distribution provided with the WWTP Impact Analysis.

The Napa Pipe Development's proposed onsite recycled water use was evaluated with an H2OMap Hydraulic Model previously developed for the District's recycled water system to investigate if the additional use would impact the recycled water system. The model indicated that the Development's onsite recycled water use had minimal impact on the system and no additional improvements beyond those already planned are expected.

For recent pipeline design purposes (described in Section 3), inputs to the hydraulic model included both existing and then-anticipated future demands along the north branch of the District's recycled water distribution system. This model was run again with the addition of the Napa Pipe onsite demands for both initial and ultimate development scenarios along the north branch of the system. Established model inputs indicated that landscape irrigation customers were expected to irrigate 10 hours per day, from 5:00am to 10:00am and from 6:00pm to 11:00pm. Napa Pipe demands were added under the same assumption. The results of this comparison are summarized in **Table 7**.

Table 7. Impacts of Napa Pipe Demand

Scenario	Maximum Velocity Upstream of Napa Pipe (ft/sec)		Pressure Changes
	Without Napa Pipe	With Napa Pipe	
Initial	3.1	3.4	Pressure decreases throughout system are negligible. SPS capacity is sufficient.
Ultimate	7.5	7.8	Pressure decreases throughout system are negligible. SPS capacity will be sufficient assuming SPS is upgraded to meet ultimate demands by adding a similar sized, third pump to supply the north branch[1].

Note:
1. The model results for the ultimate scenarios shows that the SPS will need to be increased to 19.26 mgd from 18.89 mgd (baseline model without Napa Pipe Development recycled water use). This is about a 1.9% increase in the SPS capacity.

With the annual recycled water use of 52 acre-feet/year (AFY) necessary to be offset by the Development, and onsite recycled water use of 44 AFY, approximately 8 AFY of additional recycled water use is needed to offset the Napa Pipe wastewater flows.

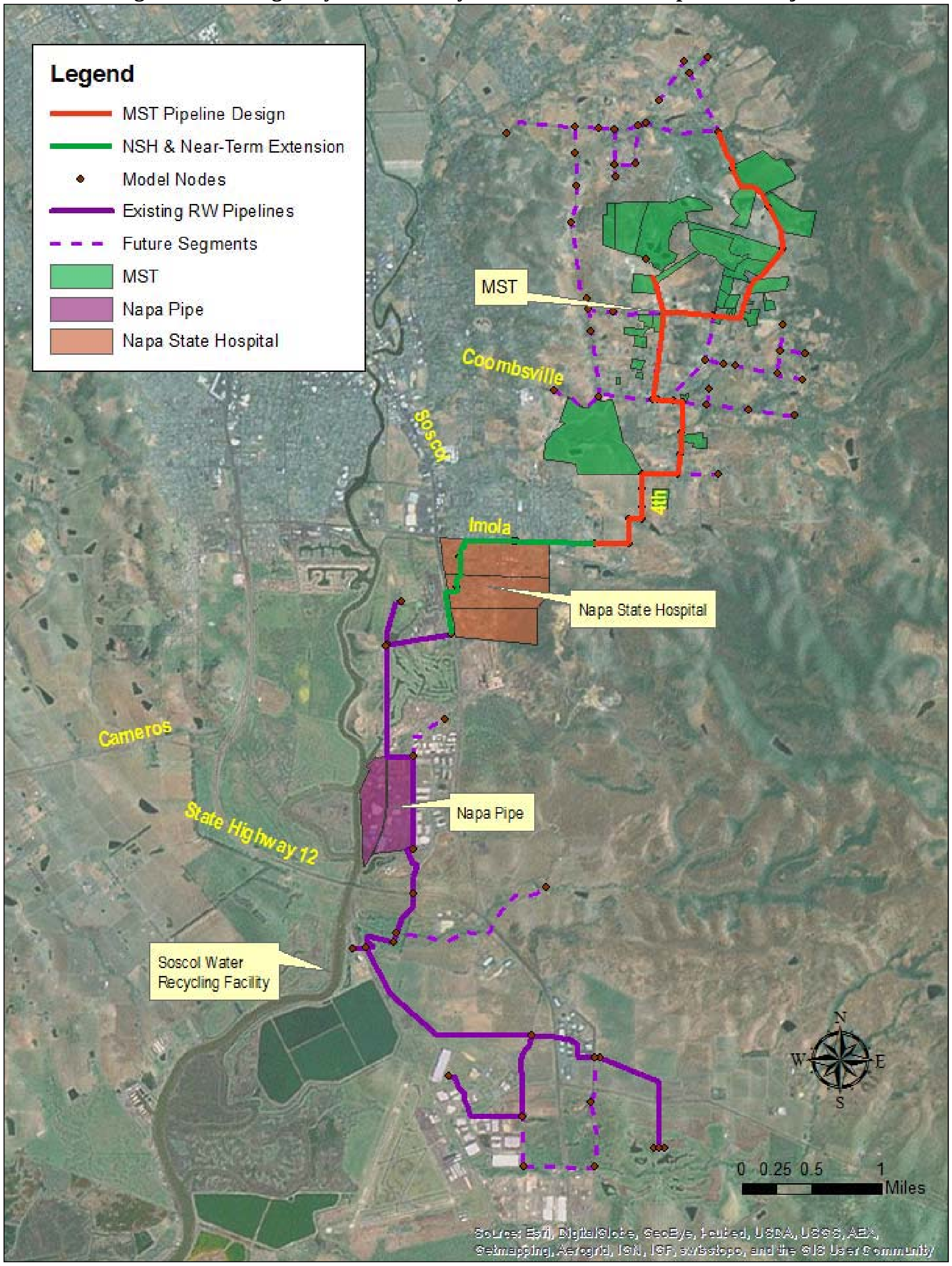
3 Potential Recycled Water Use to Provide Offset

As indicated above, any expansion of the District's recycled water system must be consistent with current and probable commitments. Of the projects on this planning list, only those that were likely to provide significant offset opportunity, and for which private funding had not yet been identified, were included in this analysis. Based on the District's recycled water priorities, only recycled water offset projects that would be an extension of the north branch of the existing system were considered.

In developing potential offset projects, it became apparent that (1) complete projects would be required to qualify for offset projects, and (2) the specific offset project to be implemented would depend on the timing of the Napa Pipe development. To identify a viable offset project, two approaches with different timing and constraints were evaluated in detail and described below. Following those two approaches, other potential offset projects are described briefly, in the event that the timing of those projects may match up more closely with the ultimate timing of the Napa Pipe Development project.

The first of the two offset projects evaluated in detail includes construction of a transmission pipeline to extend the distribution system beyond the Napa State Hospital (NSH) property into the Milliken-Sarco-Tulocay (MST) area. The second approach to an offset project, depending on the timing of the Napa Pipe Development, would involve retrofit of onsite NSH facilities for recycled water use and connection to the transmission pipeline which is expected to be under construction shortly. The locations and general pipeline alignment for these two projects are shown in **Figure 2**.

Figure 2. Existing Recycled Water System and Potential Expansion Projects



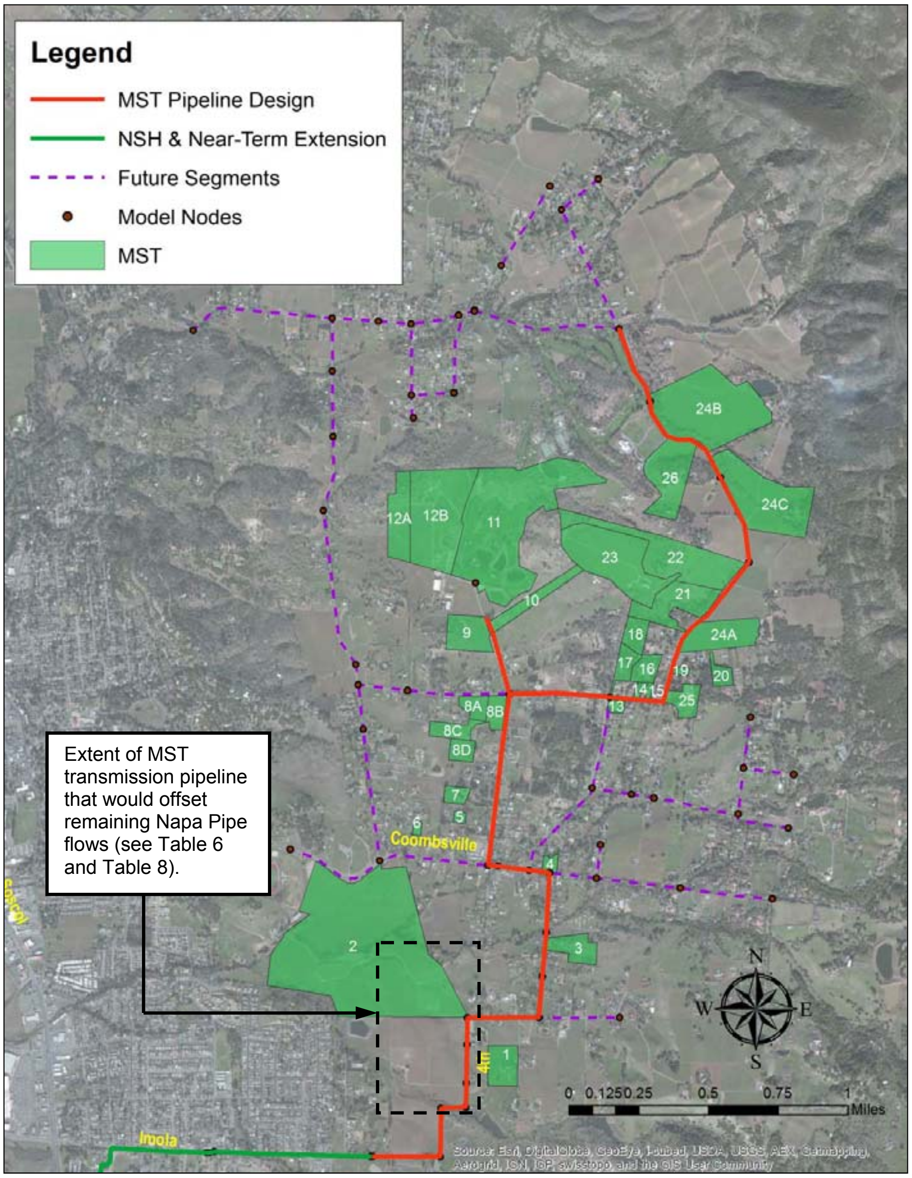
These two projects are appropriate to consider at this time because they are high priorities on the District's list of existing commitments (but future users), consistent with the District's recycled water policy, not yet completely funded, and planning and design information is available to provide an estimate of the infrastructure impacts and investment required to deliver recycled water to the sites for additional offset. Details of the specific projects are included in the following report subsections.

3.1 MST

Design work for a pipeline that would reach initial customers in the MST area has been completed. Future segments are anticipated to meet ultimate demands. The designed and future pipelines are shown in **Figure 3**. This figure also shows the alignment of the transmission pipeline that has been constructed through the NSH property and the adjoining segment for which funding for construction has been secured (collectively, NSH and near-term extension). The NSH and MST pipelines were designed to accommodate anticipated ultimate demands on the system.

Partial funding for construction of both the NSH and the MST extensions has been obtained via a federal grant administered through the American Recovery and Reinvestment Act of 2009 (ARRA). However, Napa County is still in the process of identifying potential sources of funding to cover the majority of the remaining costs of the MST pipeline construction.

Figure 3. MST Pipeline with Prospective Customers



Estimated average annual recycled water demands for initial prospective customers in the MST area are shown in **Table 8**. Installation of the portion of the transmission pipeline and turnouts (as designed) to reach the first two initial users along the MST pipeline route would be sufficient to meet the remaining offset requirement of 8 AFY. Recycled water users would be responsible for any onsite retrofits.

Table 8. MST Initial Estimated Average Recycled Water Demands (1)

Site ID	Recycled Water Customer Name	Type of Land Use	Vineyards	Landscape	Estimated Annual Demand	Cumulative Demand (2)
			(acres)	(acres)	AF	AFY
1	Kent	Vineyard	--	--	2.00	2.00
2	Faust Vineyards	Vineyard	110.56	--	35.51	37.51
3	Fitch	SFR	--	--	1.00	38.51
4	Espinoza	SFR	--	--	1.00	39.51
5	McCann	SFR	--	--	1.00	40.51
6	Gennet	SFR	--	--	1.00	41.51
7	Davidson (1087 Simpkins Rd)	SFR	--	--	1.00	42.51
8A	Simpkins	Vineyard	3.50	--	1.03	43.54
8B	Simpkins	Vineyard	3.48	--	1.03	44.57
8C	Simpkins	Vineyard	1.31	--	1.03	45.59
8D	Simpkins	Vineyard	2.45	--	1.03	46.62
9	Pierret (New Owner - Nicholson)	Vineyard	4.58	--	6.69	53.30
10	Richardson	SFR	--	--	1.00	54.30
11	Napa Valley Country Club	Landscape	--	96.00	150.00	204.30
12A	Zheng Winery - All Vineyard (West Site)	Vineyard	9.00	--	4.01	208.31
12B	Zheng Winery - Lupine Hill Vineyard (East Site)	Vineyard	11.45	--	5.73	214.04
13	Drinker	SFR	--	--	1.00	215.04
14	Beck	SFR	--	--	1.00	216.04
15	Tynan	SFR	--	--		216.04
16	Liles (2053 North 3rd Ave)	SFR	--	--	1.00	217.04
17	Bunsow	SFR	--	--	1.00	218.04
18	Marum	SFR	--	--	1.00	219.04
19	Hall	SFR	--	--	1.00	220.04
20	Gallagher	SFR	--	--	0.00	220.04
21	Dunlap	SFR	--	--	1.00	221.04
22	Blue Oak Hill Vineyard (Leavitt)	Vineyard	17.98	--	6.88	227.93
23	Meteor Vineyard (Schuler)	Landscape	--	5.00	11.95	239.88
24A	Nickel and Nickel - Barrow Lane	Vineyard	15.49	--	5.15	245.03
24B	Nickel and Nickel - Carpenter	Vineyard	42.44	--	6.84	251.86
24C	Nickel and Nickel - John's Creek	Vineyard	21.75	--	11.52	263.38
25	Bottini	SFR	--	--	1.00	264.38
26	Sodaro Estate	Vineyard	8.00	--	5.20	269.58

Site ID	Recycled Water Customer Name	Type of Land Use	Vineyards	Landscape	Estimated Annual Demand	Cumulative Demand (2)
			(acres)	(acres)	AF	AFY
	TOTAL:		**252**	**101**	**270**	**270**

Notes:

Blue shading indicates initial users along the MST pipeline route that would be sufficient to meet the remaining offset requirement for Napa Pipe.

SRF: Single Family Residence

1. Estimated annual demand data provided by District staff on February 12, 2014. Blue
2. Additive demand by potential customer.
3. The vineyard acreage is uncertain for this customer and annual demand value was estimated.

The final design plans and specifications (RMC Water and Environment, 2014) provides for, in addition to the new recycled water pipeline, the new booster pump station (BPS-1) with two project alternatives. The pump station would be located on Napa State Hospital property fronting Imola Avenue at Wilkins Avenue; the larger alternative includes three 75-horsepower vertical turbine pumps with the option for capacity increase and smaller alternative includes three 125-horsepower pumps (RMC, 2014).

3.2 Napa State Hospital

The District has a commitment to provide up to 200 acre-feet/year of recycled water to NSH for landscape irrigation. However, NSH cannot receive recycled water until connections from the transmission pipeline to the NSH irrigation system have been constructed and until onsite irrigation facilities have been retrofit for recycled water. Preliminary design work for an onsite Loop Pipeline to connect the systems has been conducted (Brown and Caldwell, 2006), but the project has not been completed. Estimated recycled water demands for irrigation of the NSH property are shown graphically in **Figure 4** and quantitatively in **Table 9**.

Figure 4. Napa State Hospital Irrigation Area

Source: Alignment Study (Brown and Caldwell, 2006)

Table 9. Napa State Hospital Estimated Median Recycled Water Demand

Area	Connection[1]	Acreage of Turf	Demand AFY
A&B[2]	Magnolia Avenue	61	**156**
C	Shurtleff Avenue	13.8	**35**
Total		74.8	**191**

Notes:

1. Area and connection breakdown shown here is as described in the Alignment Study (Brown and Caldwell, 2006).
2. These two projects (A and B) come as one unit. It is not currently possible to separate them due to the hydraulic connections in the existing system. The offset project would comprise of both A and B.

As an alternative to MST, connection of Area C would be sufficient to offset the remaining incremental flows from Napa Pipe.

3.3 Other Future Expansion Projects

Three other projects were selected from the list of existing and potential users that could provide alternate opportunities for offset depending on the timing of the Napa Pipe Development. These three are Stanly Ranch, Los Carneros Water District, and the Coombsville Road extension.

Stanly Ranch

The District adopted a resolution in May 2011 that conditionally provided for the annexation of 472 acres (or 16 of the 18 lots) of the area known as Stanly Ranch. The main purpose of this annexation is to provide wastewater and recycled water service to four lots (93 acres) that comprise a planned resort known as St. Regis, 42 acres of which is expected to be cultivated as vineyards. The other twelve lots (379 acres) were included primarily to establish recycled water service for agricultural irrigation. Close to 80% of the area included in the annexation currently comprise commercial vineyards (LAFCO, 2011).

The District has committed up to 200 AFY of recycled water to Stanly Ranch on the condition that the property owners and developers construct necessary infrastructure within five years of annexation. The recycled water pipeline through Stanly Ranch must be built in order to then connect and serve the Los Carneros region. If after five years from the annexation of Stanly Ranch the St Regis project has not been developed as planned, it may be necessary to identify an alternate source of funding to construct the pipeline through Stanly Ranch to serve Los Carneros.

Los Carneros Water District

As shown in Table 2, the District is currently committed to delivering 450 AF of recycled water per year to the Los Carneros Recycled Water (LCWD) service area. There has been discussion with LCWD to potentially increase this allocation by 1,200 AF per year.

Over the years, a number of studies and proposed recycled water pipeline alignments have been prepared for the Los Carneros Recycled Water Pipeline. A recent study includes 263 parcels (5,887 acres) of land within the LCWD and its sphere of influence. LCWD comprises mostly vineyards with some landscaping, gardens, and pasture irrigation. It was estimated that approximately 73% of the property area in the District was irrigable with 90 percent vines and 10 percent landscaping (LCWD, 2011).

Coombsville Road Extension

Several properties located along Coombsville Road adjacent to the proposed MST pipeline have been identified as potential recycled water users. These properties include the Tulocay Cemetery, the Silverado Middle School and a small vineyard, with an estimated median recycled water demand of 64 AFY (Brown and Caldwell, 2006). Construction and connection of this extension will be possible after the MST pipeline is constructed.

4 Conclusions and Mitigation Approach

Based on the water balance included in the WWTP Impact Analysis, the total amount of recycled water generated by the Napa Pipe Development that must be offset in order to minimize impacts to the District's facilities is 52 AFY. This volume may be partially offset by onsite use, currently estimated at 44 AFY, with a net estimated amount to offset off-site of 8 AFY. However, the Napa Pipe Development may need to offset flows greater than 8 AFY depending on actual onsite recycled water use.

The off-site offset can be achieved by the construction of one or more recycled water projects outside the Napa Pipe Development. The necessary offset project(s) must be constructed prior to the commencement of construction for the Napa Pipe Development.

Napa Sanitation District Recycled Water Feasibility Study for Napa Redevelopment Partners

Addendum to Napa Pipe Recycled Water Impact Analysis

The timing of the Napa Pipe Development project and the commitments made by the Napa Sanitation District to existing and potential recycled water users will dictate which recycled water offset projects are appropriate for implementation. This document describes two potential projects in detail, and three potential projects briefly. If the Napa Pipe Development proceeds immediately, the MST project comprising a pipeline to serve the first two users north of NSH may be the most efficient, however it will likely be more costly than the NSH project. If the Napa Pipe Development will be implemented at a later date, the NSH project connecting Area C could be implemented, since it is likely less costly than the MST project, but it will may take more time to coordinate administrative matters with NSH.

If the Napa Pipe Development proceeds after NSH and MST have been completed, the Development would need to mitigate its flows through an alternative project. Potential users in that case would include Stanly Ranch, the Los Carneros Water District, or the Coombsville Road extension.

Napa Sanitation District Recycled Water Feasibility Study for Napa Redevelopment Partners

Addendum to Napa Pipe Recycled Water Impact Analysis

References

Brown and Caldwell (October 2006), *Alignment Study, Prepared for Napa Sanitation District.*

Brown and Caldwell (October 2006), *Recycled Water Hydraulic Assessment Report, Prepared for Napa Sanitation District.*

Brown and Caldwell (May 2007), *Recycled Water Expansion Hydraulic and Preliminary Engineering Analysis: Phase 1 Report – Milliken-Sarco-Tulocay Area, Prepared for Napa Sanitation District.*

Brown and Caldwell (January 2009), *Recycled Water Expansion Hydraulic and Preliminary Engineering Analysis: Phase 1 Report - Addendum MST Alternative, Prepared for Napa Sanitation District.*

Brown and Caldwell and Carollo (April 2011), *Wastewater Treatment Master Plan, Prepared for Napa Sanitation District.*

Brown & Caldwell (January 2014), *Napa Pipe Wastewater Treatment Plant Impact Analysis Addendum*.

California Regional Water Quality Control Board, San Francisco Bay Region (February 2011), *Order No. R2-2011-0007, NPDES Permit CA. 0037575*.

GardenSoft (2011), *Water-Wise Gardening in Napa Valley*, http://www.napa.watersavingplants.com, accessed September 26, 2011.

Larry Walker Associates (August 2005), *Strategic Plan for Recycled Water Use in the Year 2020.*

Local Agency Formation Commission of Napa County (LAFCO) (June 2011), *Agenda Item No. 6a (Public Hearing), Subject: Stanly Ranch Annexation to the Napa Sanitation District.*

Los Carneros Water District (LCWD) (2011), http://carneroswater.org/Shared%20Documents/Feasibility%20Study%20Key.txt, accessed October 11, 2011.

Napa Redevelopment Partners (August 21, 2013), *Napa Pipe Development Plan: Draft.*

Napa County (August 2011), *Milliken-Sarco-Tulocay Recycled Water Project*, http://www.countyofnapa.org/MST, accessed October 4, 2011.

Napa Sanitation District (April 2011), *Resolution No. 11-004, Recycled Water Policy*.

Napa Sanitation District, *Water Recycling at Napa Sanitation District*. http://www.napasan.com/, accessed March 24, 2014.

RMC Water and Environment (February 2014), *MST Recycled Water Project Booster Pump Sta. No. 1.*

Winzler and Kelly (October 2007), *Napa Sanitation District, Collection System Master Plan, Final Report*.

SCHOOLS

Exhibit G.1 Excerpt from School Facilities Funding Agreement

EXCERPT FROM SCHOOL DISTRICT FUNDING AGREEMENT

Exhibit G.1 Excerpt from School Facilities Funding Agreement

Recording Requested by:

NAPA VALLEY UNIFIED SCHOOL DISTRICT

When recorded mail to:
Napa Valley Unified School District
2425 Jefferson St.
Napa, CA 94558

Attn: Assistant Superintendent, Business Services

Space above this line for Recorder's use only.
Exempt from recording fee pursuant to Govt. Code §6103.

SCHOOL FACILITIES FUNDING AGREEMENT BETWEEN NAPA VALLEY UNIFIED SCHOOL DISTRICT AND NAPA REDEVELOPMENT PARTNERS, LLC

THIS SCHOOL FACILITIES FUNDING AGREEMENT BETWEEN NAPA VALLEY UNIFIED SCHOOL DISTRICT AND NAPA REDEVELOPMENT PARTNERS, LLC ("***SFF/Agreement***") is made and entered into as of this 14 day of January 2013, between NAPA VALLEY UNIFIED SCHOOL DISTRICT ("***School District***") and NAPA REDEVELOPMENT PARTNERS, LLC, a California limited liability company ("***Owner***"). School District and Owner may hereinafter be referred to individually as "***Party***" and collectively as "***Parties***."

RECITALS

A. Owner is the owner and proposed developer of certain real property, a portion of which is located in the unincorporated area of Napa County, California ("***County***") as depicted in ***Exhibit "A"*** and legally described in ***Exhibit "B"*** ("***Owner's Property***"). Owner's Property within the County includes an approximately sixty-three (63) acre parcel ("***Parcel 1***"), and an approximately ninety-one (91) acre parcel ("***Parcel 2***"), as depicted in Exhibit A. The County Planning Commission ("***Planning Commission***") has reviewed and recommended approval of a revised application for land use entitlement approvals submitted by Owner to County. Owner's revised application for land use entitlement approvals include, but is not limited to, a draft Supplemental Environmental Impact Report, General Plan Amendment, and changes in land use zoning classification of Owner's Property ("collectively, ***Project Approvals***"). The application for Project Approvals as to Parcel 1 proposes the development of (1) 945 non-age restricted

1

BAW&G/AB/ST/158237.24 FINAL

dwelling units ("***Parcel 1 Dwelling Units***"), (2) a 150 unit, age-restricted, continuing care, retirement center, assisted living facility for senior citizens restricted as provided by Government Code Section 65995.1, ("***Senior Units***"), (3) a 150 room hotel with supporting uses, (4) 40,000 square feet of neighborhood serving commercial uses, (5) 15,600 square feet of community facilities, and (6) 10,000 square feet of other space uses (collectively as to (3), (4), (5) and (6), "***Commercial/Industrial Development***"). The application for Project Approvals on Parcel 2 proposes no residential dwelling units, but provides for Commercial/Industrial Development, including a site for a future Costco, and an approximately 10 "***Net Usable Acre***" school site (***"Proposed School Site"),*** as defined in Section 1859.74.1 of the regulations of the State Allocation Board ("***SAB***" and "***SAB Regulations***"). The School District agrees to consider a comparable "***Alternative Location***" for the Proposed School Site, provided that relocation will not impose additional economic or other burdens on School District as to the feasibility of such Alternative Location and is compatible with School District's education policies, all as reasonably determined by School District. The proposed Alternative Location for the Proposed School Site shall be subject to School District obtaining approval, at no cost to School District, or Owner, on terms and conditions acceptable to School District of environmental proceedings as described in Section 19 and from all governmental or quasi-governmental agencies having jurisdiction as to the use of the Proposed School Site for school facility purposes, including, but not limited to the Department of Toxic Substance Control ***("DTSC")***, the California Department of Education (***"CDE"***), and the Division of State Architect (***"DSA"***), at no cost to School District or Owner as to any proposed Alternative Location for the Proposed School Site to the extent such costs have been incurred by School District as to the Proposed School Site shown on Exhibit A. The proposed land uses for Parcel 1 and Parcel 2 are depicted in Exhibit A. ("***Revised Project***").

B. School District is responsible for providing school facilities for students in kindergarten through the twelfth grade ("***K-12***") who reside within School District.

C. Development of Parcel 1, and any subsequent Project Approvals for non-age restricted residential dwelling units on Parcel 2 will generate additional K-12 school students ("***Project Students***") to be enrolled in the school facilities of the School District. The funding for school facilities for non-age restricted residential dwelling units on Parcel 2 will be addressed by the Parties if and when proposed for Parcel 2, and provided for by an "***Addenda***" to this SFF/Agreement. Based on Project Approvals for up to 945 Parcel 1 Dwelling Units as recommended by the Planning Commission, the Parties estimate that 282 Project Students in grades K-8 will be generated by the 945 Parcel 1 Dwelling Units as shown in ***Exhibit "C."*** Subject to the provisions of this SFF/Agreement as to any future non-age restricted residential dwelling units on Parcel 2 and payment of Statutory School Fees (hereinafter defined in Recital G) for Senior Units complying with Government Code Section 65995.1 and the Commercial/Industrial Development of the Project, the Parties have agreed that the Owner's responsibility for providing school facilities are limited to the Contractual Mitigation Payments (hereinafter defined in Section 3) and Property Purchase Agreement (hereafter defined in Recital

D). The Contractual Mitigation Payments provided for herein are for the costs associated with design and construction of a K–8 school facility as shown in Exhibit C (*"School Facilities"*). The Parties acknowledge that the School District shall be responsible for school facilities for the Grade 9-12 Project Students generated by the Parcel 1 Dwelling Units. Owner shall have no obligation or responsibility to fund any costs in addition to the herein provided Contractual Mitigation Payments (hereinafter defined in Section 3), Property Purchase Agreement (hereinafter defined in Recital D), and Statutory School Fees (hereinafter defined in Recital G) associated with providing interim school facilities, central administration and support costs or any interim or permanent transportation costs for Project Students, subject to the reference hereinabove relating to non-age restricted residential dwelling units, if any, in Parcel 2.

D. Owner and School District agree, prior to approval and recordation of the first parcel map or final subdivision map applicable to Owner's Property, to execute a "***Property Purchase Agreement***" based on the form of ***Exhibit "D,"*** providing for the conveyance of the Proposed School Site from Owner to School District, with the understanding that the final form of the Property Purchase Agreement is still to be negotiated between the Owner and the School District.

E. Subject to the Project Approvals having been Finally Granted (as defined in Recital H, below), Owner presently anticipates commencing construction of the Parcel 1 Dwelling Units in the year 2015, resulting in the generation of Project Students to be housed by School District. The District will need the School Facilities in order to accommodate the Grade K-8 Project Students resulting from development of the Parcel 1 Dwelling Units.

F. School District and Owner agree that given the necessity for the School Facilities, and due to uncertainty regarding potential future increases in costs of constructing the required School Facilities and the availability, timing and amount of State Funding (as hereinafter defined) for such School Facilities, it is in their mutual best interest to enter into this SFF/Agreement to, among other things, set forth Owner's agreed obligation to provide funding for the School Facilities and the Proposed School Site and School District's agreed obligation to construct and operate the School Facilities as herein provided.

G. Owner's execution and performance of Owner's obligations of this SFF/Agreement, as well as execution and performance by the Parties of the Property Purchase Agreement, is intended to constitute full and complete mutually agreed mitigation of all impacts as to the Revised Project as described herein. The Parties' execution and performance hereof are in lieu of any fees, charges, dedications or other requirements which the School District might impose on development as described herein as to the Revised Project, pursuant to Education Code Section 17620 *et seq.* and Government Code Section 65995, *et seq.*("***Statutory School Fees***"), and are in lieu of any other school facilities requirements which the School District might be otherwise authorized to impose pursuant to applicable existing or future law on development as described in the Revised Project. The Parties agree that execution and performance of this

SFF/Agreement and the Property Purchase Agreement constitutes "full and complete mitigation" as to development as described in the Revised Project as contemplated by applicable law, except as to Commercial/Industrial Development and Senior Units, which shall pay the applicable Statutory School Fees prior to issuance of a "***Certificate of Compliance***" for a building permit as provided for in Education Code Section 17620(b) & (c) .

H. The Parties understand that the Project Approvals recommended by the Planning Commission, must be approved by the Board of Supervisors of County ("***Board of Supervisors***"), and be Finally Granted (as hereafter defined). Project Approvals shall be considered to have been "***Finally Granted***" for purposes of this SFF/Agreement on the date on which (1) any and all applicable appeal periods for the filing of any administrative appeal or judicial action challenging the issuance or effectiveness of any of the Project Approvals shall have expired and no such appeal or judicial action shall have been filed within any applicable statute of limitations, or, if such an administrative appeal or judicial action is filed, the Project Approvals shall have been upheld by a final decision in each such administrative appeal or judicial action without adverse effect on the applicable Project Approvals, and the entry of a final judgment, order or ruling upholding the applicable Project Approvals, and (2) if a referendum petition relating to the Project Approvals is timely and duly circulated and filed, certified as valid and the County holds an election, the date the election results on the ballot measure are certified by the County in the manner provided by the Election Code reflecting the final defeat or rejection of the referendum. This SFF/Agreement assumes that the Board of Supervisors approves the Project Approvals for the Revised Project. If the Board of Supervisors' approval of the Revised Project includes Parcel 1 Dwelling Units that differ materially from the Revised Project as described herein, then the Parties shall meet and confer in good faith, and amend this SFF/Agreement based upon the development as approved by the Board of Supervisors, on the basis of the Project Student generation rates and estimated construction costs set forth in Exhibit C. In the event the Board of Supervisors grants the Project approval now pending for less than 945 Parcel 1 Dwelling Units, Owner within 60 calendar days, shall have the right to terminate this SFF/Agreement. If Owner, or its successors and assigns, constructs more than 945 Parcel 1 Dwelling Units, all such Parcel 1 Dwelling Units shall pay the herein provided Contractual Mitigation Payment. If the product type changes and School District using the student generation rates as used in preparing Exhibit C, determines that more than 282 Project Students will result from the 945 Parcel 1 Dwelling Units, the Contractual Mitigation Payments shall be increased consistent with Exhibit C. If Owner does not agree with such determination by School District, the matter shall be resolved pursuant to Section 14, and future dwelling units shall pay a revised Contractual Mitigation Payment, consistent with Exhibit C, determined as herein provided to proportionately fund any additional School Facilities to accommodate any such additional Project Students.

TRANSPORTATION DEMAND MANAGEMENT PLAN

Excerpt From Board of Supervisors June 4, 2013 Resolution No. 2013-60/CEQA Findings (Exhibit B: NP MMRP), attached as Exhibit XI.

Mitigation Measure TRA-1b: To lessen the severity of this and other significant peak hour impacts, the project applicant shall establish a transportation demand management (TDM) program which shall be funded and administered by the property owners association with the goal of reducing the forecasted auto trip generation from the project by 15 percent. The TDM program shall include certain required (immediate, long term) measures, as follows.

Required TDM Measures

- Establish a full-time, paid TDM coordinator to implement required TDM measures, monitor their effectiveness and implement additional measures as needed to meet the 15 percent goal. The coordinator shall also monitor volumes and delays at intersections where traffic mitigation measures have been called for.
- Implement peak period shuttle service to key employment centers (e.g. hospital, downtown) or provide funding to allow relocation of the nearby VINE route to serve the site, with added service in peak periods.
- Implement a parking management program to establish and monitor compliance with parking restrictions.

The effectiveness of these required measures shall be monitored on a biannual basis, and traffic counts will be conducted to determine if the 15 percent reduction of forecasted traffic levels is being achieved. If additional measures are necessary to achieve the 15 percent reduction, the TDM coordinator shall implement other measures to enhance the TDM program. Below is a selection of additional measures that may be considered to achieve a reduction in auto traffic:

- Develop incentives for employer programs
- Guaranteed Ride Home Program
- Information kiosk w/brochures
- Newsletter articles
- Advertised carpool information phone number
- Annual promotional events
- Car-share program
- Shuttles to regional transit like the Vallejo ferry
- Transit Subsidies
- Water taxis
- On-site Ticket Sales (some level also included in existing, initial, moderate)
- Carpool/Vanpool Subsidies (Start up, empty seat subsidies)
- Employer-owned/sponsored Vanpools
- Fleet Vehicles for mid-day trips
- On-site circulator shuttle or golf-carts and/or campus bicycles
- Aggressive flextime/telecommute programs

KITTELSON MEMO

Exhibit I.1 - Kittelson Memo

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING / PLANNING
101 S Capitol Boulevard, Suite 301, Boise, ID 83702 P 208.338.2683 F 208.338.2685

MEMORANDUM

Date: October 9, 2012 Project #: 12708

To: Michael Okuma, Costco Wholesale
David Franklin, McKenna Long & Aldridge LLP

From: Sonia Hennum, PTOE

Project: Napa Pipe Costco Development
Subject: Costco Gasoline Transportation Information

This memorandum provides the vehicle trip and vehicle queuing information requested to complete greenhouse gas emissions and air quality impact analysis for the proposed Costco development that is being considered as part of the Napa Pipe development in Napa, California. This information has been compiled based on data collected at other representative Costco developments and focuses in particular on vehicle trip generation and idling at the Costco Gasoline fuel station proposed as part of the Costco development.

The requested information related to vehicles trips is summarized in Table 1.

Table 1 Costco Gasoline Vehicle Trip Estimate

	Estimated Fuel Station Trip Generation								
	Weekday PM Peak Hour Trip Ends			**Weekday Daily Trip Ends**			**Weekend Daily Trip Ends**		
	In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Total Trips	250	250	500	2,495	2,495	4,990	2,190	2,190	4,380
Internal Trips[1] (34%)	*(85)*	*(85)*	*(170)*	*(845)*	*(845)*	*(1,690)*	*(745)*	*(745)*	*(1,490)*
External Trips	165	165	330	1,650	1,650	3,300	1,445	1,445	2,890
Pass-by & Diverted Trips[2] (74% of external)	*(120)*	*(120)*	*(240)*	*(1,215)*	*(1,215)*	*(2,430)*	*(1,070)*	*(1,070)*	*(2,140)*
Net New Trips	**45**	**45**	**90**	**435**	**435**	**870**	**375**	**375**	**750**

1. Internal trips account for those members who patronize both the warehouse and the gasoline pumps during a single visit to the Costco site. As such, although they account for a trip to both the warehouse and the fuel station, they only account for one vehicle trip to the site and on the surrounding transportation system. Based on studies including surveys at Costco Gasoline stations and membership card transaction data, on average 34% of the members buying gas are members whose main purpose to the site is to visit the Costco warehouse and who can be classified as an internal trip.

FILENAME: C:\USERS\SHENNUM\DESKTOP\NAPA COSTCO GASOLINE AIR QUALITY INFORMATION.DOCX

2. Pass-by trips represent members (and trips) that are currently traveling on the surrounding street network for some other primary purpose (such as a trip from work to home) and stop into the site en route during their normal travel. As such, pass-by trips do not result in a net increase in traffic on the surrounding transportation system and, typically, their only effect occurs at the immediate intersections and site access driveways where they become turning movements. Diverted trips are similar to pass-by trips in that they are trips already on the surrounding transportation system they stop into the site during their course of travel. They differ from pass-by trips in that they would not be on the roadways immediately adjacent to the site during their normal travel and, therefore, have to divert from a roadway further away to travel to the site. Although they may be a new trip on the roadways immediately adjacent to the site, they are not a new trip on the overall transportation system. Based on studies using surveys at Costco Gasoline fuel stations, on average 74% of the external trips at Costco Gasoline fuel station can be classified as either pass-by or diverted trips. The breakdown between pass-by and diverted trips is dependent on the site location and surrounding transportation system.

The requested information related to vehicle queuing is summarized in Table 2. This information was developed based on daily summaries of vehicle queuing at other Costco Gasoline locations.

Table 2 Costco Gasoline Vehicle Queuing Estimate

	Total Weekday Daily Vehicle Hours in Queue
Costco Gasoline Fuel Station	91 vehicle-hours

We trust this memorandum provides the information requested related to vehicle trips and queuing for the Costco Gasoline facility proposed as part of the Napa Pipe development. Please contact us at shennum@kittelson.com or (208) 338-2683 if you have any questions or if you require any additional information.

TRAFFIC IMPACT FEE MITIGATION PROGRAM

Exhibit J.1 - Excerpt from NAPA Pipe transportation Analysis Sensitivity Test

FEHR & PEERS

MEMORANDUM

Date: June 28, 2013

To: Hillary Gitelman, County of Napa

From: Chris Mitchell, Steve Crosley & Nikki Foletta

Subject: ***Napa Pipe Transportation Analysis Sensitivity Test***

SF06-0290.08

Fehr & Peers conducted a sensitivity test of existing and future traffic conditions at 12 intersections within the City of Napa with and without the Napa Pipe Costco Alternative "Costco Alternative". The purpose of this exercise was to assess the degree to which different assumptions with respect to baseline traffic counts, project trip generation, and future traffic forecasts would affect conclusions from the Napa Pipe EIR with respect to project specific impacts, cumulative impacts, mitigation, and fair share contribution. The sensitivity tests were conducted the following 12 study locations located in the City of Napa:

1. Lincoln Ave / Soscol Ave
2. First St / Soscol Ave
3. First St / Silverado Trail
4. Third St / Soscol Ave
5. Third St / Solverado Trail (SR 121)
6. Silverado Trail (SR 121) / Soscol Ave
7. SR 29 Southbound Ramps / Imola Ave
8. SR 29 Northbound Ramps / Imola Ave
9. Imola Ave (SR 121) / Jefferson St
10. Imola Ave (SR 121) / Coombs St
11. Imola Ave (SR 121) / Gasser Dr
12. Imola Ave (SR 121) / Soscol Ave

In order to provide a complete understanding of the Costco Alternative's impacts, mitigation, and fair share contribution at all 34 study intersections included in the EIR analysis, this analysis also includes LOS and impact analysis for the remaining 22 intersections from a prior analysis, documented in *Napa Pipe Impact Comparison – Costco Alternative / Proposed Project* (Fehr & Peers, September 2012). Three attachments to this memo are included: A) Fair share contribution calculations; B) Level of service worksheets for the 12 sensitivity test locations; and C) Level of service worksheets for the remaining 22 intersections from a prior analysis.

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www.fehrandpeers.com

FEHR PEERS

SENSITIVITY TEST

The sensitivity test evaluated traffic conditions at the 12 study intersections for the following four scenarios:

- *Existing Conditions* – provides an evaluation of current operations based on existing traffic volumes during the weekday AM and PM peak periods. Intersection turning-movement counts were obtained from *Metropolitan Transportation Commission Program for Arterial System Synchronization (PASS) for State Route 29, Redwood Road/Trancas Street, Lincoln Avenue, First Street, Imola Avenue (Highway 121), and Soscol Avenue* (2011), and *Metropolitan Transportation Commission Program for Arterial System Synchronization (PASS) for Soscol Avenue and Silverado Trail* (2012). Signal timing inputs were obtained from the same study.
- *Existing Plus Project Conditions* – adds estimated traffic generated by the project to existing volumes. New trip generation estimates for the Costco Alternative (shown in **Table 1)** were prepared by Ruetgers and Shuler and approved by the City of Napa. Trip assignment and distribution were unchanged from the previous impact analysis.
- *Cumulative No Project Conditions* – incorporates planned population and employment growth and planned transportation system improvements for the year 2035, based on output from the Napa/Solano County Travel Demand Forecasting (TDF) Model (updated by Fehr & Peers for the Solano Transportation Authority in 2010, validated to 2010 conditions).[1]
- *Cumulative Plus Project Conditions* – analyzes forecasts developed by adding project-related traffic to the Cumulative No Project volumes. Trip generation uses the same forecasts as developed for the Existing Plus Project analysis.

[1] The N-STDM was initially developed by DKS Associates and Dowling Associates and validated to the base year of 2000. In 2008, DKS refreshed the base year land use data with input by City staff from various jurisdictions in Napa and Solano Counties, including the City of Napa, Napa County, and the City of Vallejo. In 2010, the model was updated by Fehr & Peers for the Solano Transportation Authority, where the base year was validated to 2010 conditions and special trip generators were established in Solano County. The land use data from remaining jurisdictions and unincorporated areas in Napa and Solano Counties were based on the MTC regional travel model. Land use data from other Bay Area counties were based on ABAG's Projections 2005. The N-STDM covers the nine Bay Area counties, the Sacramento Region, San Joaquin County, and Lake County.

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TABLE 1: COSTCO ALTERNATIVE TRIP GENERATION FOR SENSITIVITY TEST (INTERSECTIONS 1-12)					
		AM Peak Hour Trips		PM Peak Hour Trips	
Development Type	**Size**	**External Trips In**	**External Trips Out**	**External Trips In**	**External Trips Out**
Residential Condominium/Townhouse	945 DU	70	341	203	100
Assisted Living	150 beds	11	6	12	14
Hotel	150 rooms	37	23	42	38
Elementary School	500 students	51	42	19	19
Office	100 ksf	132	18	26	126
Light Industrial/R&D	75 ksf	69	14	10	54
Shopping Center	40 ksf	11	7	34	35
Costco (discount club)	154 ksf	49	20	261	261
Totals		**430**	**471**	**607**	**647**

Source: Ruetgers and Shuler, 2013

IMPACT ANALYSIS

The sensitivity test used the same impact criteria used for the EIR.

Signalized Intersections

Impacts at a signalized intersection would be significant if:

- The proposed project would degrade the AM or PM peak hour LOS from an acceptable LOS D or better to LOS E or F; or
- The proposed project would increase traffic volumes at an intersection already operating at LOS E or F by more than 50 vehicles per hour in the AM or PM peak hour. Due to typical daily fluctuations in traffic volumes, this is considered the volume change at intersections operating at LOS E or F that is perceptible to drivers.

An intersection can be mitigated to a *less-than-significant* level if an infrastructure improvement or traffic volume reduction results in the intersection operating at an acceptable LOS D or better. If an intersection is currently operating at an unacceptable LOS E or worse, the improvement must, at a minimum, return the intersection to its existing operating conditions to achieve a *less-than-significant* classification.

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Unsignalized Intersections

Impacts at an unsignalized intersection would be significant if:

- The proposed project would degrade the AM or PM peak hour LOS from an acceptable LOS D or better to LOS E or F and the worst-case approach would experience total delay of more than 4.0 vehicle-hours (for a single lane approach) or more than 5.0 vehicle hours (for a multi-lane approach); or
- The proposed project would increase traffic volumes at an intersection already operating at LOS E or F by more than 50 vehicles per hour in the AM or PM peak hour.

The same mitigation criteria explained above for signalized intersections applies to unsignalized intersections.

LOS AND IMPACT DETERMINATION

Table 2 compares the AM and PM peak hour intersection LOS at each of the original 34 study intersections for Existing and Existing Plus Project Conditions. **Table 3** compares the AM and PM peak hour intersection LOS at each of the original 34 study intersections for Cumulative and the Cumulative plus Project Conditions. As part of the sensitivity test, Intersections 1 through 12 were reassessed using new volumes and signal timings as described above. The intersection delay, LOS, and impact determination for intersections 13-34 were taken from *Napa Pipe Impact Comparison – Costco Alternative / Proposed Project*.

The following describes impacts at the twelve intersections included in the sensitivity test analysis.

Existing Plus Project Conditions - As shown in the Table 2:

- *Intersection 5* (Third St/Silverado Tr. (SR 121)/East Ave/Coombsville Rd) operates at LOS E under both the Existing and Existing Plus Project (Costco Alternative) scenarios during both the AM and PM peak periods. However, since the project does not contribute more than 50 vehicle trips per hour, this impact is *less-than-significant*.
- *Intersection 8* (SR 29 Northbound Ramps/Imola Ave) operates at LOS E under both the Existing and Existing Plus Project (Costco Alternative) scenarios during the AM peak period. However, since the project does not contribute more than 50 vehicle trips per hour, this impact is *less-than-significant*.
- *Intersection 12* (Imola Ave (SR 121)/Soscol Ave) operates at LOS F under both the Existing and Costco Alternative scenarios during the PM peak period. Since the project contributes more than 50 trips during the PM peak hour, this is considered a **significant impact**.

Cumulative Plus Project Conditions - As shown in the Table 3:

- *Intersection 1* (Lincoln Ave/Soscol Ave) operates at LOS E under both the Cumulative No Project and Cumulative Plus Project (Costco Alternative) scenarios during the PM peak period. Since the project contributes more than 50 trips during the PM peak hour, this is considered a **significant impact**.

- *Intersection 5* (Third St/Silverado Tr. (SR 121)/East Ave/Coombsville Rd) operates at LOS F under both the Cumulative No Project and Cumulative Plus Project (Costco Alternative) scenarios during both the AM and PM peak periods. However, since the project does not contribute more than 50 vehicle trips per hour, this impact is *less-than-significant*.
- *Intersection 9* (Imola Ave (SR 121)/Jefferson St) operates at LOS E under both the Cumulative No Project and Cumulative Plus Project (Costco Alternative) scenarios during the PM peak period. However, since the project does not contribute more than 50 vehicle trips per hour, this impact is *less-than-significant*.
- *Intersection 12* (Imola Ave (SR 121)/Soscol Ave) operates at LOS F under both the Cumulative No Project and Cumulative Plus Project (Costco Alternative) scenarios during both the AM and PM peak periods. Since the project contributes more than 50 trips during the PM peak hour, this is considered a **significant impact**.

IMPACT SUMMARY

Table 4 summarizes the significant impacts prior to mitigation for the existing and cumulative scenarios. Note that Intersections 1 through 12 show the results of the sensitivity test and Intersections 13 through 34 show results from the impact analysis conducted for and described in *Napa Pipe Impact Comparison – Costco Alternative / Proposed Project*.

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TABLE 2: EXISTING PEAK HOUR INTERSECTION LEVEL OF SERVICE ANALYSIS

Intersection	Traffic Control[1]	Existing Conditions				Costco Alternative			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS
1. Lincoln Ave/Soscol Ave	Signal	23	C	31	C	24	C	31	C
2. First St/ Soscol Ave	Signal	14	B	28	C	20	C	50	D
3. First St/Silverado Trail	Signal	16	B	19	B	16	B	19	B
4. Third St/ Soscol Ave	Signal	21	C	21	C	21	C	24	C
5. Third St/Silverado Tr. (SR 121)/East Ave/Coombsville Rd	Signal	**75**	**E**	**72**	**E**	**76**	**E**	**78**	**E**
6. Silverado Trail (SR 121)/Soscol Ave	Signal	14	B	21	C	17	B	35	C
7. SR 29 Southbound Ramps/Imola Ave	Signal	29	C	19	B	30	C	20	B
8. SR 29 Northbound Ramps/Imola Ave	Signal	**67**	**E**	49	D	**68**	**E**	52	D
9. Imola Ave (SR 121)/Jefferson St	Signal	31	C	44	D	31	C	44	D
10. Imola Ave (SR 121)/Coombs St	Signal	35	C	53	D	35	C	53	D
11. Imola Ave (SR 121)/Gasser Dr	Signal	17	B	53	D	17	B	53	D
12. Imola Ave (SR 121)/Soscol Ave	Signal	35	C	**>80**	**F**	38	D	**>80**	**F**
13. SR 221 (Napa-Vallejo Highway)/Streblow Dr	Signal	42	D	24	C	**74**	**E**	44	D
14. Kaiser Rd/Syar Industrial Way	SSS[3]	10 (SB)	B	18 (SB)	C	9	A	13	B
15. Kaiser Rd/Napa Valley Corporate Dr	SSS[3]	10 (NB)	B	9 (NB)	A	10	A	11	B
16. Kaiser Rd/Enterprise Way	SSS	14 (SB)	B	15 (SB)	B	19 (SB)	C	26 (SB)	D
17. SR 221 (Napa-Vallejo Highway)/Kaiser Rd	Signal	15	B	11	B	46	D	45	D
18. Napa Valley Corp. Dr/Latour Ct[2]	SSS	N/A	N/A	N/A	N/A	12 (EB)	B	11 (EB)	B
19. Napa Valley Corp. Dr/Napa Valley Corp. Way[2]	AWS	N/A	N/A	N/A	N/A	9	A	12	B
20. Napa Valley Corp. Way/SR 221 (Napa-Vallejo Hwy.)	Signal	37	D	22	C	25	C	30	C
21. Napa Valley Corporate Dr/Trefethen Way[2]	SSS	N/A	N/A	N/A	N/A	14 (WB)	B	16 (WB)	C
22. Napa Valley Corporate Dr/Anselmo Ct[2]	SSS	N/A	N/A	N/A	N/A	14 (EB)	B	**>50 (EB)**	**F**
23. SR 12-SR 121/SR 29	Signal	53	D	52	D	41	D	35	C
24. Napa Valley Corporate Dr/Soscol Ferry Rd	SSS	9 (NB)	A	12 (NB)	B	10 (NB)	B	14 (NB)	B
25. Soscol Ferry Rd/Devlin Rd	SSS	9 (NB)	A	**36 (NB)**	**E**	**>50 (NB)**	**F**	**>50 (NB)**	**F**
26. SR 12-SR 29/SR 221 (Napa-Vallejo Highway)	Signal	**>80**	**F**	**>80**	**F**	**>80**	**F**	**>80**	**F**
27. Airport Blvd/SR 29-SR 12	Signal	**>80**	**F**	**66**	**E**	**>80**	**F**	**>80**	**F**
28. SR 29/ South Kelly Road	Signal	48	D	19	B	45	D	21	C
29. SR 29/ Napa Junction Road	Signal	**> 80**	**F**	54	D	**> 80**	**F**	50	D

FEHR & PEERS

TABLE 2: EXISTING PEAK HOUR INTERSECTION LEVEL OF SERVICE ANALYSIS

Intersection	Traffic Control[1]	Existing Conditions				Costco Alternative			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS
30. SR 29/ Donaldson Way	Signal	**>80**	**F**	24	C	**> 80**	**F**	22	C
31. SR 29/American Canyon Rd	Signal	**>80**	**F**	54	D	**>80**	**F**	**61**	**E**
32. American Canyon Rd/ Broadway St	Signal	7	A	8	A	7	A	7	A
33. American Canyon Rd/ Newell Rd	Signal	24	C	20	B	25	C	16	B
34. SR 29/SR 37 Westbound Off-Ramp	Signal	30	C	26	C	35	C	28	C
Total Intersections with Unacceptable Operations:		***9***				***11***			
Total Project-Significant Impacts:		-				***9***			

Note: **Bold** = unacceptable LOS, not a significant impact; **Shaded** = Significant Impact**;** Signal = Signalized intersection; AWS = All-Way Stop-Controlled intersection; SSS = Side-Street Stop-Controlled intersection

(XX) = indicates worst case approach where WB = westbound, EB = eastbound, NB = northbound, and SB = southbound

1. Signalized and AWS intersection LOS based on average control delay per vehicle, according to the HCM. Side-street stop-controlled intersection level of service based on worst approach control delay, according to the HCM-Special Report 209 (Transportation Research Board, 2000).
2. Intersection not analyzed under existing conditions.
3. Project proposes to install a roundabout as intersection treatment. Multi-lane roundabout analysis performed per the FHWA 2000 and NCHRP 572 methodology.

Source: Fehr & Peers, 2013.

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TABLE 3: CUMULATIVE (YEAR 2030) PEAK HOUR INTERSECTION LEVEL OF SERVICE

Intersection	Traffic Control[1]	Alternative 1A Baseline				Costco Alternative			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS
1. Lincoln Ave/Soscol Ave	Signal	34	C	**73**	**E**	35	C	**76**	**E**
2. First St/ Soscol Ave	Signal	18	B	38	D	20	B	51	D
3. First St/Silverado Trail	Signal	25	C	21	C	25	C	24	C
4. Third St/ Soscol Ave	Signal	37	D	40	D	39	D	49	D
5. Third St/Silverado Tr. (SR 121)/East Ave/Coombsville Rd	Signal	**> 80**	**F**	**> 80**	**F**	**> 80**	**F**	**> 80**	**F**
6. Silverado Trail (SR 121)/Soscol Ave	Signal	22	C	36	D	29	C	52	D
7. SR 29 Southbound Ramps/Imola Ave	Signal	41	D	33	C	44	D	35	D
8. SR 29 Northbound Ramps/Imola Ave	Signal	11	B	28	C	11	B	32	C
9. Imola Ave (SR 121)/Jefferson St	Signal	40	D	**61**	**E**	40	D	**79**	**E**
10. Imola Ave (SR 121)/Coombs St	Signal	31	C	46	D	31	C	54	D
11. Imola Ave (SR 121)/Gasser Dr	Signal	15	B	20	C	15	B	26	C
12. Imola Ave (SR 121)/Soscol Ave	Signal	**> 80**	**F**	**> 80**	**F**	**> 80**	**F**	**> 80**	**F**
13. SR 221 (Napa-Vallejo Highway)/Streblow Dr	Signal	**> 80**	**F**	43	D	**> 80**	**F**	**71**	**E**
14. Kaiser Rd/Syar Industrial Way[2]	SSS[3]	9	A	10	B	11	B	25	C
15. Kaiser Rd/Napa Valley Corporate Dr[2]	SSS[3]	10	B	10	B	11	B	13	B
16. Kaiser Rd/Enterprise Way	SSS	27 (SB)	D	30 (SB)	D	**>50 (SB)**	**F**	**>50 (SB)**	**F**
17. SR 221 (Napa-Vallejo Highway)/Kaiser Rd	Signal	53	D	50	D	**> 80**	**F**	**> 80**	**F**
18. Napa Valley Corp. Dr/Latour Ct	SSS	12 (EB)	B	12 (EB)	B	12 (EB)	B	13 (EB)	B
19. Napa Valley Corp. Dr/Napa Valley Corp. Way	AWS	10	B	12	B	11	B	15	B
20. Napa Valley Corp. Way/SR 221 (Napa-Vallejo Hwy.)	Signal	**> 80**	**F**	**> 80**	**F**	**> 80**	**F**	**> 80**	**F**
21. Napa Valley Corporate Dr/Trefethen Way	SSS	13 (WB)	B	16 (WB)	C	16 (WB)	C	22 (WB)	C
22. Napa Valley Corporate Dr/Anselmo Ct	SSS	11 (EB)	B	19 (EB)	B	20 (EB)	C	**>50 (EB)**	**F**
23. SR 12-SR 121/SR 29	Signal	**> 80**	**F**	**> 80**	**F**	**> 80**	**F**	**> 80**	**F**
24. Napa Valley Corporate Dr/Soscol Ferry Rd	SSS	11 (NB)	B	15 (NB)	C	12 (NB)	B	19 (NB)	C
25. Soscol Ferry Rd/Devlin Rd	SSS	19 (NB)	C	**>50 (NB)**	**F**	**>50 (NB)**	**F**	**>50 (NB)**	**F**
26. SR 12-SR 29/SR 221 (Napa-Vallejo Highway)	Signal	**> 80**	**F**	**>80**	**F**	**> 80**	**F**	**> 80**	**F**
27. Airport Blvd/SR 29-SR 12	Signal	**> 80**	**F**	**>80**	**F**	**> 80**	**F**	**> 80**	**F**

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TABLE 3: CUMULATIVE (YEAR 2030) PEAK HOUR INTERSECTION LEVEL OF SERVICE									
Intersection	Traffic Control[1]	Alternative 1A Baseline				Costco Alternative			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS
28. SR 29/ South Kelly Road	Signal	**> 80**	**F**	**>80**	**F**	> 80	F	> 80	F
29. SR 29/ Napa Junction Road	Signal	**> 80**	**F**	**>80**	**F**	> 80	F	> 80	F
30. SR 29/ Donaldson Way	Signal	**> 80**	**F**	**>80**	**F**	> 80	F	> 80	F
31. SR 29/American Canyon Rd	Signal	**> 80**	**F**	**> 80**	**F**	> 80	F	> 80	F
32. American Canyon Rd/ Broadway St	Signal	38	D	18	B	37	D	28	C
33. American Canyon Rd/ Newell Rd	Signal	**58**	**E**	**> 80**	**F**	**63**	**E**	**> 80**	**F**
34. SR 29/SR 37 Westbound Off-Ramp	Signal	**> 80**	**F**	**> 80**	**F**	> 80	F	> 80	F
Total Intersections with Unacceptable Operations:		**16**				**19**			
Total Significant Impacts with Project Contributions:		**-**				**16**			

Note: **Bold** = unacceptable LOS, not a significant impact,; **Shaded** = Significant Impact**;** AWS = All-Way Stop-Controlled intersection; SSS = Side-Street Stop-Controlled intersection

(XX) = indicates worst case approach where WB = westbound, EB = eastbound, NB = northbound, and SB = southbound

1. Signalized and AWS intersection LOS based on average control delay per vehicle, according to the HCM. Side-street stop-controlled intersection level of service based on worst approach control delay, according to the HCM-Special Report 209 (Transportation Research Board, 2000).
2. Project proposes to install a roundabout as intersection treatment. Multi-lane roundabout analysis performed per the FHWA 2000 and NCHRP 572 methodology.

Source: Fehr & Peers, 2013.

Hillary Gitelman
June 28, 2013
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TABLE 4: SUMMARY OF SIGNIFICANT IMPACTS PRIOR TO MITIGATION

Intersection	Scenario			
	Existing[1]	Costco Alternative	Cumulative No Project[1]	Cumulative Costco Alt
1. Lincoln Ave/Soscol Ave			✓	X
2. First St/ Soscol Ave				
3. First St/Silverado Trail				
4. Third St/ Soscol Ave				
5. Third St/Silverado Tr. (SR 121)/East Ave/Coombsville Rd	✓		✓	
6. Silverado Trail (SR 121)/Soscol Ave				
7. SR 29 Southbound Ramps/Imola Ave				
8. SR 29 Northbound Ramps/Imola Ave	✓			
9. Imola Ave (SR 121)/Jefferson St			✓	
10. Imola Ave (SR 121)/Coombs St				
11. Imola Ave (SR 121)/Gasser Dr				
12. Imola Ave (SR 121)/Soscol Ave	✓	X	✓	X
13. SR 221 (Napa-Vallejo Highway)/Streblow Dr		X	✓	X
14. Kaiser Rd/Syar Industrial Way				
15. Kaiser Rd/Napa Valley Corporate Dr				
16. Kaiser Rd/Enterprise Way			✓	X
17. SR 221 (Napa-Vallejo Highway)/Kaiser Rd			✓	X
18. Napa Valley Corp. Dr/Latour Ct				
19. Napa Valley Corp. Dr/Napa Valley Corp. Way				
20. Napa Valley Corp. Way/SR 221 (Napa-Vallejo Hwy.)			✓	X
21. Napa Valley Corporate Dr/Trefethen Way				
22. Napa Valley Corporate Dr/Anselmo Ct		X		X
23. SR 12-SR 121/SR 29			✓	X
24. Napa Valley Corporate Dr/Soscol Ferry Rd				
25. Soscol Ferry Rd/Devlin Rd	✓	X	✓	X
26. SR 12-SR 29/SR 221 (Napa-Vallejo Highway)	✓	X	✓	X
27. Airport Blvd/SR 29-SR 12	✓	X	✓	X
28. SR 29/South Kelly Road			✓	X
29. SR 29/Napa Junction Road	✓	X	✓	X
30. SR 29/Donaldson Way	✓	X	✓	X
31. SR 29/American Canyon Rd	✓	X	✓	X
32. American Canyon Road/Silver Oak Trail/Broadway St				
33. American Canyon Road/Newell Road			✓	
34. SR 29/SR 37 Westbound Off-Ramp			✓	X
Total Significant Impacts:		9		16

Note: **X** = Significant Impact Prior to Mitigation ✓ = Unacceptable operating conditions

1 Intersections with unacceptable operating conditions are reported. No project trips would exist under this scenario; therefore, the significance criteria is not applicable.

Source: Fehr & Peers, 2011, 2013

MITIGATION MEASURES

This section of the memo describes impacts generated by the Costco Alternative and mitigation measures for all study locations impacted by the project, under Existing and Cumulative Conditions. Intersections 1 through 12 reflect the sensitivity test impact analysis (noted with *Sensitivity Test* next to intersection description) and Intersections 13 through 34 reflect the impact analysis conducted for and described in *Napa Pipe Impact Comparison – Costco Alternative / Proposed Project*.

EXISTING PLUS PROJECT TRAFFIC IMPACTS AND MITIGATION MEASURES

Intersection 12: Imola Avenue (SR 121) / Soscol Avenue (Sensitivity Test)

The intersection of Imola Avenue (SR 121) and Soscol Avenue was found to be operating at LOS F under both Existing Conditions and Costco Alternative conditions during the PM peak hour. 570 trips were added to this intersection by the project. This is a **significant impact**.

Mitigation Measure: Construct an additional left-turn lane on the eastbound approach and an exclusive right-turn lane on the westbound approach. Because the intersection was operating at unacceptable LOS under existing conditions, the project applicant shall pay its fair share to the construction of this project. If implemented, the intersection would operate at LOS D in the PM peak hour. It would operate better than existing conditions, even with the addition of project traffic. The project's impact would be reduced to a *less-than-significant* level.

Intersection 13: SR 221 / Streblow Drive

The addition of project traffic at the intersection of SR 221 (Napa-Vallejo Highway) and Streblow Drive is expected to cause the intersection to deteriorate from LOS D to LOS E in the AM peak hour. This is a **significant impact**.

Mitigation Measure: Construct an additional northbound left-turn lane on SR 221 (Napa-Vallejo Highway) and a receiving lane on Streblow Drive. The operations of this intersection should be monitored prior to implementing this improvement to confirm the need. Construction of the improvement shall be at the discretion of the City of Napa. The project applicant shall pay 100% of the cost of this improvement. With mitigation, 95th percentile queues for the northbound left-turn lanes are expected to be served by the available storage, assuming that the additional turn-lane is the same length as the existing turn-lane. These improvements would reduce the project's impact at this intersection to a *less-than significant* level.

Intersection 22: Napa Valley Corporate Drive/Anselmo Court

Under Existing Plus Project Conditions, the Costco Alternative would result in unacceptable operating conditions in the PM peak hour at Intersection 22, Napa Valley Corporate Drive/Anselmo Court. This is a **significant impact**.

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Mitigation Measure: Vehicle traffic resulting from the Costco Alternative would cause this intersection to satisfy the MUTCD Peak Hour Signal Warrant in the PM peak hour. The intersection could be signalized to provide acceptable operations (LOS D or better).

While signalization would be a feasible mitigation measure, an alternative mitigation for a roundabout is proposed, which would improve operations to an acceptable level if a single-lane roundabout was implemented. It is recommended to install a single-lane roundabout with a bypass lane installed on the southbound and eastbound approaches of the intersection. This mitigation measure should be constructed prior to occupancy. The applicant is responsible for 100% of the cost for construction of the project.

Intersection 25: Soscol Ferry Road/Devlin Road

The addition of project traffic at the intersection of Soscol Ferry Road and Devlin Road is expected to cause the intersection to deteriorate from LOS A to LOS F in the AM peak hour and from LOS E to LOS F in the PM peak hour. This is a **significant impact**.

Mitigation Measure: The mitigation measure proposed for Soscol Ferry Road/Devlin Road is a traffic signal and a median treatment on Soscol Ferry Road that essentially controls all movements except for the westbound through movement on Soscol Ferry Road. This mitigation measure should be constructed prior to occupancy. If these improvements were implemented, the Costco Alternative's impact at Soscol Ferry Road/Devlin Road would be reduced to a *less-than significant* level. The applicant is responsible for 100% of the cost for construction of the project.

Intersection 26: SR 12 – SR 29 / SR 221

The intersection of SR 12 – SR 29 / SR 221 (Napa-Vallejo Highway) was found to be operating at LOS F under both Existing Conditions and Costco Alternative conditions during both the AM and PM peak hours. 562 AM peak hour trips and 544 PM peak hour trips were added to this intersection by the project. This is a **significant impact**.

Mitigation Measure: Construct flyover ramp for the traffic traveling from southbound SR 221 (Napa-Vallejo Highway) to southbound SR 12/SR 29. This improvement has been contemplated previously by the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. Removing the southbound left turning traffic from the signalized portion of this intersection improves this intersection to acceptable LOS D in the AM and PM peak hours. This would reduce the project's impact at this intersection to a *less-than significant* level.

Intersection 27: Airport Boulevard / SR 29 – SR 12

The intersection of Airport Boulevard and SR 12 – SR 29 was found to be operating at LOS F during the AM peak hour and LOS E during the PM peak hour under Existing Conditions. The addition of project trips (>50) would cause the intersection to operate at LOS F during both the AM and PM peak hours. This is a **significant impact**.

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Mitigation Measure: Construct grade-separated interchange as proposed in the Napa County General Plan. This improvement has been contemplated previously by the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. Construction of this interchange would improve operations at this location to acceptable levels and would reduce the project's impact to a less-*than-significant* level.

Intersection 29: SR 29 / Napa Junction Road
The project is expected to contribute to existing LOS F conditions in the AM peak hour (>50 trips). This is a **significant impact**.

Mitigation Measure: The Napa County General Plan calls for widening of SR 29 from the SR 221 (Napa-Vallejo Highway) interchange to the southern County Line. In order to mitigate the project's significant impact, the additional through lane on SR 29 in the northbound and southbound directions should be constructed at this intersection, as is currently proposed. This improvement has been contemplated previously by the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. With the widening of SR 29, this intersection would improve to acceptable LOS C in the AM and PM peak hours. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level.

Intersection 30: SR 29 / Donaldson Way
The project is expected to contribute to existing LOS F conditions in the AM peak hour (>50 trips). This is a **significant impact**.

Mitigation Measure: The Napa County General Plan calls for widening of SR 29 from the SR 221 (Napa-Vallejo Highway) interchange to the southern County Line. In order to mitigate the project's significant impact, the additional through lane on SR 29 in the northbound and southbound directions should be constructed at this intersection, as is currently proposed. This improvement has been contemplated previously by the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. With the widening of SR 29, this intersection would improve to acceptable LOS C in the AM and PM peak hours. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level.

Intersection 31: SR 29 / American Canyon Road
The project is expected to contribute to existing LOS F conditions in the AM peak hour (279 AM peak hour trips) and to cause the intersection to deteriorate from LOS D to LOS E in the PM peak hour. This is a **significant impact**.

Mitigation Measure: The City of American Canyon's General Plan recognizes that this intersection will likely operate at LOS E conditions during peak periods. The Napa County General Plan also calls for widening of SR 29 from the SR 221 (Napa-Vallejo Highway) interchange to the southern County Line. In order to mitigate the project's significant impact, the additional through lane on

SR 29 in the northbound and southbound directions should be constructed at this intersection, as is currently proposed. This improvement has been contemplated previously by the City of American Canyon, the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. With the widening of SR 29, this intersection would continue to operate at LOS F in the AM peak hour (primarily due to the extremely heavy westbound right turn to northbound SR 29), but would operate better than Existing conditions without the project. The intersection would improve to LOS D in the PM peak hour. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level.

CUMULATIVE PLUS PROJECT TRAFFIC IMPACTS AND MITIGATION MEASURES

Intersection 1: Lincoln Avenue / Soscol Avenue (Sensitivity Test)

The project is expected to contribute to cumulative LOS E conditions in the PM peak hour (63 PM peak hour trips). This is a **significant impact**.

Mitigation Measure: Construct an additional left-turn lane on both the northbound and southbound approaches. Because the intersection was operating at unacceptable LOS under cumulative conditions, the project applicant shall pay its fair share to the construction of this project. If implemented, the intersection would operate at LOS D in the PM peak hour. It would operate better than Cumulative No Project conditions. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level.

Intersection 12: Imola Avenue / Soscol Avenue (Sensitivity Test)

The project is expected to contribute to cumulative LOS F conditions in both the AM and PM peak hours. This is a **significant impact**.

Mitigation Measure: Applying the mitigation measure suggested for the Existing Plus Project impact (construct an additional left-turn lane on the eastbound approach, and an exclusive right-turn lane on the westbound approach) would improve Cumulative Plus Project conditions to operate better than Cumulative No Project conditions. However, LOS would remain at F. Therefore, with mitigation the project would operate better than Cumulative No Project conditions and the impact would be considered *less-than-significant*. As documented above, the applicant will pay its fair share to the construction of this project.

If, in addition to the mitigation measure suggested above, an additional through lane were added on Soscol Avenue in both the northbound and southbound directions and an additional through lane on Imola Avenue in the eastbound direction, the LOS during both the AM and PM peak hours would be improved to LOS E. These changes were discussed in the Napa Pipe DEIR and in prior City of Napa studies, but their feasibility is uncertain.

Intersection 13: SR 221 / Streblow Drive

The project is expected to contribute to cumulative LOS F conditions in both the AM and PM peak hours. This is a **significant impact**.

Mitigation Measure: Construct an additional northbound left-turn lane on SR 221 (Napa-Vallejo Highway) and a receiving lane on Streblow Drive. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level. As documented above, the applicant should pay 100% of the cost for construction of this project.

Intersection 16: Kaiser Road / Enterprise Way

The addition of project traffic at the intersection of Kaiser Road and Enterprise Way is expected to cause the intersection to deteriorate from LOS D to LOS F in the AM peak hour and from LOS E to LOS F in the PM peak hour. This is a **significant impact**.

Mitigation Measure: The mitigation measures proposed for Kaiser Road/Enterprise Way includes re-striping the southbound approach to provide dedicated left- and right-turn lanes. If this improvement was implemented, the critical southbound approach would continue to operate at LOS F in the PM peak hour with more than 5.0 vehicle-hours of delay[2]; thus, the Costco Alternative's impact to this intersection would be *significant and unavoidable*.

The mitigation measures proposed also include a peak hour left-turn restriction on the southbound approach, forcing motorists to turn right from Enterprise Way onto westbound Kaiser Road and travel 180-degrees around the proposed roundabout at Kaiser Road/Napa Valley Corporate Drive in lieu of the left-turn egress from Enterprise Way. If this improvement was implemented, the Costco Alternative's impact at Kaiser Road/Enterprise Way would be reduced to a *less-than-significant* level. The applicant would be required to pay its fair share towards construction of the project.

Intersection 17: SR 221 / Kaiser Road

The addition of project traffic at the intersection of SR 221 (Napa-Vallejo Highway) and Kaiser Road is expected to cause the intersection to deteriorate from LOS D to LOS F in the AM peak hour and from LOS E to LOS F in the PM peak hour. This is a **significant impact**.

Mitigation Measure: Extend the turn-pocket to 500 feet from its current length of approximately 280 feet or create a dual left-turn the length of the current turn-lane to adequately store the expected queues. In addition, construct the following improvements:

- Northbound: a third through lane and a second left-turn lane
- Southbound: a third through lane and free right-turn lane
- Eastbound: a second and third left-turn lane and a free right-turn lane What is LOS after mitigation

Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level. The applicant would be required to pay its fair share towards construction of the project.

[2] Per significance criteria for unsignalized intersections with a multi-lane approach.

Intersection 20: Napa Valley Corp. Way / SR 221
The addition of project traffic at the intersection of Napa Valley Corp. Way and SR 221 (Napa-Vallejo Highway) is expected to contribute to cumulative LOS F conditions in both the AM and PM peak hours. This is a **significant impact**.

Mitigation Measure: Construct third through lanes in both the northbound and southbound approaches and construct a second left-turn lane on the northbound approach. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level. The applicant would be required to pay its fair share towards construction of the project.

Intersection 22: Napa Valley Corp. Drive / Anselmo Court
The addition of project traffic at the intersection of Napa Valley Corporate Drive and Anselmo Court is expected to cause the intersection to deteriorate from LOS C to LOS F in the PM peak hour. This is a **significant impact**.

Mitigation Measure: While signalization would be a feasible mitigation measure, an alternative mitigation for a roundabout is proposed. Assuming planned cumulative roadway improvements, the intersection would improve operations to an acceptable level if a single-lane roundabout was implemented. It is recommended to install a single-lane roundabout with a bypass lane installed on the southbound and eastbound approaches of the intersection. With these improvements, the impact at Napa Valley Corporate Drive/Anselmo Court would be reduced to a level below significance. As documented above, the applicant would pay 100% of the cost for construction of this project.

Intersection 23: SR 12 – SR 121 / SR 29
The project is expected to contribute to cumulative LOS F conditions in both the AM and PM peak hours. This is a **significant impact**.

Mitigation Measure: Construct third through lanes in both the northbound and southbound approaches and construct the following improvements:

- Northbound: a second left-turn lane
- Eastbound: a second right-turn lane.

Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level. The applicant would be required to pay its fair share towards construction of the project.

Intersection 25: Soscol Ferry Road / Devlin Road
The addition of project traffic at the intersection of Soscol Ferry Road and Devlin Road is expected to cause the intersection to deteriorate from LOS D to LOS F in the PM peak hour. This is a **significant impact**.

Mitigation Measure: The mitigation measure proposed for Soscol Ferry Road/Devlin Road in the 2009 DEIR is the signal and a median treatment (from Existing + Project mitigation) and a fair

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share contribution to the planned SR 221 to SR 29 flyover and other roadway modifications that constitute the planned cumulative roadway improvements. If these planned roadway improvements were implemented, the Costco Alternative's impact at Soscol Ferry Road/Devlin Road would be reduced to a *less-than significant* level. As documented previously, the applicant would pay 100% of the cost for construction of this project.

Intersection 26: SR 12 – SR 29 / SR 221
The intersection of SR 12 – SR 29 / SR 221 (Napa-Vallejo Highway) was found to be operating at LOS F under both Cumulative Conditions and Cumulative with Costco Alternative conditions during both the AM and PM peak hours. 562 AM peak hour trips and 544 PM peak hour trips were added to this intersection by the project. This is a **significant impact**.

Mitigation Measure: Construct flyover ramp for the traffic traveling from southbound SR 221 (Napa-Vallejo Highway) to southbound SR 12/SR 29. This improvement has been contemplated previously by the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. This would reduce the project's impact at this intersection to a *less-than significant* level.

Intersection 27: Airport Boulevard / SR 29 – SR 12
The intersection of Airport Boulevard and SR 12 – SR 29 was found to be operating at LOS F under both Cumulative Conditions and Cumulative with Costco Alternative conditions during both the AM and PM peak hours. The addition of project trips would exceed the 50 trip threshold. This is a **significant impact**.

Mitigation Measure: Construct grade-separated interchange as proposed in the Napa County General Plan prior to occupancy of the project. This improvement has been contemplated previously by the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. Construction of this interchange would improve operations at this location to acceptable levels and would reduce the project's impact to a less-*than-significant* level.

Intersection 28: SR 29 / South Kelly Road
The project is expected to contribute to cumulative LOS E conditions in the PM peak hour. This is a **significant impact**.

Mitigation Measure: Construct third through lanes in both the northbound and southbound approaches and construct a second northbound left-turn lane. The project applicant shall pay its fair share to the construction of this project. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level.

Intersection 29: SR 29 / Napa Junction Road
The project is expected to contribute to cumulative LOS F conditions in the AM & PM peak hour (>50 trips). This is a **significant impact**.

Mitigation Measure: The Napa County General Plan calls for widening of SR 29 from the SR 221 (Napa-Vallejo Highway) interchange to the southern County Line. In order to mitigate the project's significant impact, the additional through lane on SR 29 in the northbound and southbound directions should be constructed at this intersection, as is currently proposed. This improvement has been contemplated previously by the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level.

Intersection 30: SR 29 / Donaldson Way
The project is expected to contribute to cumulative LOS F conditions in the AM and PM peak hours (>50 trips). This is a **significant impact**.

Mitigation Measure: The Napa County General Plan calls for widening of SR 29 from the SR 221 (Napa-Vallejo Highway) interchange to the southern County Line. In order to mitigate the project's significant impact, the additional through lane on SR 29 in the northbound and southbound directions should be constructed at this intersection, as is currently proposed. This improvement has been contemplated previously by the County and Caltrans, and would be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project. With the widening of SR 29, this intersection would improve to acceptable LOS in the AM and PM peak hours. Implementation of this mitigation measure would result in the impact being reduced to a *less-than-significant* level.

Intersection 31: SR 29 / American Canyon Road
The project is expected to contribute to cumulative LOS F conditions in both the AM and PM peak hours. This is a **significant impact**.

Mitigation Measure: This intersection was identified in the 2009 DEIR as having no feasible means of achieving acceptable operations. The intersection may be able to be improved to operate acceptably by constructing large-scale intersection treatments, such as grade separation, continuous flow intersections, or approach realignment. However, these options are not likely to be desirable in the affected communities. Therefore this impact is considered *significant and unavoidable*.

Intersection 34: SR 29 / SR 37 Westbound Off-Ramp
The project is expected to contribute to cumulative LOS F conditions in both the AM and PM peak hours. This is a **significant impact**.

Mitigation Measure: This intersection was identified in the 2009 DEIR as having no feasible means of achieving acceptable operations. The intersection may be able to be improved to operate acceptably by constructing large-scale intersection treatments, such as grade separation, continuous flow intersections, or approach realignment. However, these options are not likely to be desirable in the affected communities. Therefore this impact is considered *significant and unavoidable*.

OPENING DAY MITIGATION – PROJECT RESPONSIBILITY

Under Existing Plus Project conditions, the Costco Alternative would result in significant impacts at nine intersections. We understand the County intends to require the Existing Plus Project mitigation measures described above at the following four intersections. Each of these mitigation measures would be constructed prior to occupancy of the project.

- *Intersection 12* - Imola Ave (SR 121) /Soscol Ave – The Costco Alternative is responsible for 19.1% of mitigation cost based on project contribution (percent of total peak hour trips) to existing LOS F conditions. We assume the remainder of funding (80.9%) would come from other sources.
- *Intersection 13* - SR 221 (Napa-Vallejo Highway)/Streblow Dr – The Costco Alternative is responsible for 100% of mitigation cost based on project degrading LOS from acceptable to unacceptable conditions.
- *Intersection 22* - Napa Valley Corporate Dr/Anselmo Ct – The Costco Alternative is responsible for 100% of mitigation cost based on project degrading LOS from acceptable to unacceptable conditions.
- *Intersection 25* - Soscol Ferry Rd/Devlin Rd – The Costco Alternative is responsible for 100% of mitigation cost based on project degrading LOS from acceptable to unacceptable conditions.

The cost breakdown of these opening day mitigation measures at these intersections is summarized in **Table 5**. The cost estimates were based on the following assumptions:

- Costs assume minimal earthwork (except for interchange projects)
- Costs include a 25% contingency factor
- Costs include a 25% factor for planning and design services
- Costs **do not** include right-of-way acquisition

It is important to note that these are rough cost estimates, based on an aerial photo evaluation of distances and constraints, and applying average unit costs for materials and labor. No surveying or mapping was conducted as a part of this effort; a relatively high contingency factor has been applied to account for the lack of precision in the estimates.

The remaining five impacted intersections would require mitigation even without development of the project and large scale improvements are planned for those locations. The project would pay a fair share contribution for those future improvements, which is described in the following section.

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TABLE 5: OPENING DAY MITIGATION PERCENTAGES AND COSTS				
#	**Impacted Intersection**	**Napa Pipe Responsibility**	**Total Cost**	**Napa Pipe Cost**
12	Imola Ave (SR 121) /Soscol Ave	19.1%	$1,100,000	$210,100
13	SR 221 (Napa-Vallejo Highway)/Streblow Dr	100%	$1,500,000	$1,500,000
22	Napa Valley Corporate Dr/Anselmo Ct	100%	$500,000	$500,000
25	Soscol Ferry Rd/Devlin Rd	100%	$270,000	$270,000
Totals			**$3,370,000**	**$2,480,100**

Fehr & Peers, 2013.

FAIR SHARE CONTRIBUTION - FUTURE IMPROVEMENTS

This section documents the methodology and results of developing a transportation mitigation cost allocation program for the Costco Alternative Cumulative plus Project scenario for the Napa Pipe project. The basic technical information used in this cost allocation program is consistent with that presented in the Napa Pipe EIR.

BACKGROUND INFORMATION

Fehr & Peers developed a cost allocation program based on each land use type associated with the Costco Alternative. For each land use type, a cost per unit of development was calculated. **Table 6** provides the land use, size, and unit type for the Costco Alternative.

The cost per unit of development for each land use type is based on the Costco Alternative's fair share contribution (highest peak hour contribution – AM or PM – was used) to significantly impacted intersections under the Cumulative plus Project scenario. The fair share contribution percentage for each impacted intersection is presented in **Table 7**.

Fair share contributions are often discussed under the Cumulative plus Project scenario when thresholds of significance are based on comparing Cumulative conditions back to Existing conditions. Simply stated, cumulative impacts are, by definition, caused by the cumulative effect of Project traffic and traffic from other reasonably foreseeable developments; the Project is not solely responsible for causing them. The Costco Alternative's fair share contribution to mitigating cumulative impacts is calculated based on the forecasted traffic growth between existing and cumulative conditions. Fehr & Peers then determined what percentage of this growth was attributable to the Costco Alternative. The contribution varies between the AM and PM peak hours, so the greater of the two was used to identify an impacted intersection's fair share contribution assigned to the Costco Alternative.

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There were two study intersections that have no feasible means of achieving acceptable operations under the Cumulative plus Project scenario:

31. SR 29 / American Canyon Road

34. SR 29 / SR 37 Westbound Off-Ramp

TABLE 6: LAND USE PROGRAM – COSTCO ALTERNATIVE

Land Use Type	Size	Unit
Condo	945	du
Senior Assisted Living	150	bed
Hotel	150	Room
Office	100	ksf
Industrial/R&D/Warehouse	75	ksf
Neighborhood Serving Retail & Restaurant	40	ksf
Elementary School	500	student
Costco	154	ksf

1. du = dwelling unit
2. ksf = thousand square feet

Source: Napa Redevelopment Partners, 2012.

As discussed in more detail in the Napa Pipe EIR, these intersections may theoretically be able to be improved to operate acceptably by constructing large-scale intersection treatments, such as grade separation, continuous flow intersections, or approach realignment. However, these options are not likely to be desirable in the affected communities, and thus these mitigations were considered infeasible. Therefore, no mitigation costs have been included for these intersections in this cost allocation program. The cost estimates that follow are only for those locations where feasible mitigations were identified in the EIR. The cost estimates were based on the following assumptions:

- Costs assume minimal earthwork (except for interchange projects)
- Costs include a 25% contingency factor
- Costs include a 25% factor for planning and design services
- Costs **do not** include right-of-way acquisition

It is important to note that these are rough cost estimates, based on an aerial photo evaluation of distances and constraints, and applying average unit costs for materials and labor. No surveying

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or mapping was conducted as a part of this effort; a relatively high contingency factor has been applied to account for the lack of precision in the estimates.

TABLE 7: FAIR SHARE CONTRIBUTION PERCENTAGES AND COSTS

#	Impacted Intersection	Napa Pipe Fair Share Percentage	Total Cost	Napa Pipe Fair Share Cost
1	Lincoln Ave/Soscol Ave	3.9%	$1,300,000	$50,700
16	Kaiser Rd/Enterprise Way	66.4%	$30,000	$19,920
17	SR 221 (Napa-Vallejo Highway)/Kaiser Rd	34.0%	$1,700,000	$578,000
20	Napa Valley Corp. Way/SR 221 (Napa-Vallejo Hwy)	11.1%	$1,700,000	$188,700
23	SR 12-SR 121/SR 29	5.5%	$2,000,000	$110,000
26	SR 12-SR 29/SR 221 (Napa-Vallejo Hwy)	10.7%	$30,000,000	$3,210,000
27	Airport Blvd/SR29-SR12	7.0%	$40,000,000	$2,800,000
28	SR 29/South Kelly Rd	10.2%	$1,800,000	$183,600
29	SR29/Napa Junction Rd	9.8%	$1,800,000	$176,400
30	SR 29/Donaldson Way	14.6%	$1,800,000	$262,800
Totals			**$82,130,000**	**$7,580,120**

Fehr & Peers, 2013.

FAIR SHARE CONTRIBUTION ALLOCATION BY LAND USE TYPE

Peak period trip generation of each Costco Alternative land use was compared to overall program trip generation to determine the proportional contribution from each land use.

Table 8 summarizes the percent of total trip generation of the Costco Alternative attributable to each land use. A blended approach, based on the sum of AM and PM peak period trip generation numbers, was used to allocate amongst the land use types.

Allocation of fair share cost by land use type/unit is based on trip generation developed by Fehr & Peers and is consistent with the methodology used in the EIR and subsequent analyses.

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TABLE 8: PERCENTAGE ALLOCATION OF TRIPS BY LAND USE TYPE								
	AM Peak Vehicle Trips			**PM Peak Vehicle Trips**			**AM + PM Peak Trips**	**% Allocation**
Land Use	**Subtotal**	**Internalized**	**Total**	**Subtotal**	**Internalized**	**Total**		
Condo	417	0	417	493	-23	470	887	**33%**
Senior Assisted Living	32	0	32	68	-3	65	97	**4%**
Hotel	85	0	85	89	0	89	174	**6%**
Office	189	0	189	192	-5	187	376	**14%**
Industrial/ R&D/ Warehouse	105	0	105	104	-3	101	206	**8%**
Neighborhood Serving Retail & Restaurant	117	0	117	221	-27	194	310	**11%**
Costco	260	-90	170	1,075	-640	435	605	**22%**
Elementary School	128	-83	45	43	-28	15	60	**2%**
Total	*1,333*	*-173*	*1,160*	*12,285*	*-730*	*1,555*	*2,715*	***100%***

Fehr & Peers, 2013.

IMPACT COST CALCULATIONS

These allocation percentages were then used to calculate the total cost by land use type per impacted intersection. Finally, the land use detail in **Table 6** was used to translate from total cost to cost by unit per impacted intersection. A high level summary of total fair share cost by unit of land use type allocated to the Costco Alternative is presented in **Table 9**.

TABLE 9: NAPA PIPE FAIR SHARE COST SUMMARY									
	Napa Pipe Fair Share Cost	**Condo**	**Senior Assisted Living**	**Hotel**	**Office**	**Industrial**	**Neighbor-hood-Serving Retail**	**Costco**	**Elementary School**
Total	$7,580,120	$2,476,875	$270,395	$485,798	$1,049,242	$575,668	$865,502	$1,689,124	$167,516
Cost per Unit		$2,621 / du	$1,803 / du	$3,239/ room	$10,492/ ksf	$7,676/ ksf	$21,638/ ksf	N/A - Lump Sum	N/A - Lump Sum

Fehr & Peers, 2013.

COST ALLOCATION REBALANCING

One of the primary goals of the Napa Pipe project is to provide housing for people who work in Napa County in a neighborhood setting that promotes walking and bicycling. In order to achieve this goal, it is critical that the project site include some neighborhood-serving retail uses, so that residents can take advantage of nearby retail opportunities. One method of supporting the achievement of this goal is to rebalance the cost allocations to reduce the cost burden on the neighborhood-serving retail uses. The elementary school was also excluded from fair share cost contributions. **Table 10** presents one option for this rebalancing, in which the total cost attributed to neighborhood-serving retail and restaurant uses was reduced to $300,000, the cost attributed to the elementary school was reduced to $0, and the remaining balance was split between the hotel, office, industrial, and Costco uses. The total fair share cost remains unchanged.

TABLE 10: FAIR SHARE COST SUMMARY WITH REBALANCING

	Napa Pipe Fair Share Cost	Condo	Senior Assisted Living	Hotel	Office	Industrial	Neighbor-hood-Serving Retail	Costco	Elementary School
Total	$7,580,120	$2,476,875	$270,395	$579,512	$1,251,649	$686,719	$300,000	$2,014,970	$0
Cost per Unit		$2,621 / du	$1,803 / du	$3,863/ room	$12,516/ ksf	$9,156/ ksf	$7,500/ ksf	N/A - Lump Sum	$0

Fehr & Peers, 2013.

Attachment A

Fair Share Contributions

Napa Pipe SF06-0290.05
Cumulative Contributions
4/24/13

Costco Alternative Fair Share Contributions

Intersection Name	Scenario	Volumes Funded Network AM	Volumes Funded Network PM	Potential Impact? (>50 Trips) Funded Network AM	Potential Impact? (>50 Trips) Funded Network PM
1. Lincoln Ave/Soscol Ave	Baseline	2,693	3,209		
	Cumulative No Project	3,700	4,890		
	Costco Alternative Project Trips	41	63		X
	Cumulative plus Costco Alternative	3,740	4,960		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.1%	1.3%		
	Costco Alternative Fair Share Contribution	***3.9%***	***3.6%***		
2. First St/ Soscol Ave	Baseline	2,010	2,956		
	Cumulative No Project	3,030	4,100		
	Costco Alternative Project Trips	182	266	X	X
	Cumulative plus Costco Alternative	3,210	4,380		
	Contribution to Cumulative Plus Costco Alternative Volumes	5.7%	6.1%		
	Costco Alternative Fair Share Contribution	***15.2%***	***18.7%***		
3. First St/Silverado Trail	Baseline	1,374	1,622		
	Cumulative No Project	2,110	2,380		
	Costco Alternative Project Trips	34	50		
	Cumulative plus Costco Alternative	2,150	2,430		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.6%	2.1%		
	Costco Alternative Fair Share Contribution	***4.4%***	***6.2%***		
4. Third St/ Soscol Ave	Baseline	2,394	2,974		
	Cumulative No Project	3,920	4,520		
	Costco Alternative Project Trips	323	469	X	X
	Cumulative plus Costco Alternative	4,250	5,000		
	Contribution to Cumulative Plus Costco Alternative Volumes	7.6%	9.4%		
	Costco Alternative Fair Share Contribution	***17.4%***	***23.1%***		
5. Third St/Silverado Tr. (SR 121)/East Ave/Coombsville Rd	Baseline	2,180	2,336		
	Cumulative No Project	3,140	3,720		
	Costco Alternative Project Trips	34	50		
	Cumulative plus Costco Alternative	3,170	3,770		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.1%	1.3%		
	Costco Alternative Fair Share Contribution	***3.4%***	***3.5%***		
6. Silverado Trail (SR 121)/Soscol Ave	Baseline	2,468	3,360		
	Cumulative No Project	3,760	4,420		
	Costco Alternative Project Trips	356	521	X	X
	Cumulative plus Costco Alternative	4,120	4,940		
	Contribution to Cumulative Plus Costco Alternative Volumes	8.6%	10.5%		
	Costco Alternative Fair Share Contribution	***21.5%***	***33.0%***		
7. SR 29 Southbound Ramps/Imola Ave	Baseline	2,084	2,036		
	Cumulative No Project	2,400	2,205		
	Costco Alternative Project Trips	18	22		
	Cumulative plus Costco Alternative	2,420	2,230		
	Contribution to Cumulative Plus Costco Alternative Volumes	0.7%	1.0%		
	Costco Alternative Fair Share Contribution	***5.4%***	***11.3%***		
8. SR 29 Northbound Ramps/Imola Ave	Baseline	2,763	2,632		
	Cumulative No Project	3,440	3,450		
	Costco Alternative Project Trips	33	49		
	Cumulative plus Costco Alternative	3,470	3,500		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.0%	1.4%		
	Costco Alternative Fair Share Contribution	***4.7%***	***5.6%***		
9. Imola Ave (SR 121)/Jefferson St	Baseline	2,747	3,003		
	Cumulative No Project	3,790	4,500		
	Costco Alternative Project Trips	32	49		
	Cumulative plus Costco Alternative	3,830	4,550		
	Contribution to Cumulative Plus Costco Alternative Volumes	0.8%	1.1%		
	Costco Alternative Fair Share Contribution	***3.0%***	***3.2%***		
10. Imola Ave (SR 121)/Coombs St	Baseline	2,765	3,192		
	Cumulative No Project	3,720	4,460		
	Costco Alternative Project Trips	32	49		
	Cumulative plus Costco Alternative	3,750	4,510		
	Contribution to Cumulative Plus Costco Alternative Volumes	0.9%	1.1%		
	Costco Alternative Fair Share Contribution	***3.2%***	***3.7%***		
11. Imola Ave (SR 121)/Gasser Dr	Baseline	2,204	2,641		
	Cumulative No Project	3,280	4,210		
	Costco Alternative Project Trips	32	49		
	Cumulative plus Costco Alternative	3,320	4,260		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.0%	1.2%		
	Costco Alternative Fair Share Contribution	***2.9%***	***3.0%***		
12. Imola Ave (SR 121)/Soscol Ave	Baseline	3,579	4,040		
	Cumulative No Project	6,230	6,460		
	Costco Alternative Project Trips	388	570	X	X
	Cumulative plus Costco Alternative	6,620	7,030		
	Contribution to Cumulative Plus Costco Alternative Volumes	5.9%	8.1%		
	Costco Alternative Fair Share Contribution	***12.8%***	***19.1%***		

Napa Pipe SF06-0290.05
Cumulative Contributions
8/31/12

Costco Alternative Fair Share Contributions					
Intersection Name	**Scenario**	**Volumes**		**Potential Impact? (>50 Trips)**	
		Funded Network		**Funded Network**	
		AM	**PM**	**AM**	**PM**
13. SR 221 (Napa-Vallejo Highway)/Streblow Dr	Baseline	4,459	4,934		
	Cumulative No Project	5,860	5,910		
	Costco Alternative Project Trips	625	520	X	X
	Cumulative plus Costco Alternative	6,490	6,420		
	Contribution to Cumulative Plus Costco Alternative Volumes	9.6%	8.1%		
	Costco Alternative Fair Share Contribution	***30.8%***	***35.0%***		
14. Kaiser Rd/Syar Industrial Way	Baseline	157	627		
	Cumulative No Project	920	1,330		
	Costco Alternative Project Trips	746	1,111	X	X
	Cumulative plus Costco Alternative	1,670	2,440		
	Contribution to Cumulative Plus Costco Alternative Volumes	44.7%	45.5%		
	Costco Alternative Fair Share Contribution	***49.3%***	***61.3%***		
15. Kaiser Rd/Napa Valley Corporate Dr	Baseline	428	608		
	Cumulative No Project	1,190	1,290		
	Costco Alternative Project Trips	745	1,110	X	X
	Cumulative plus Costco Alternative	1,940	2,400		
	Contribution to Cumulative Plus Costco Alternative Volumes	38.4%	46.3%		
	Costco Alternative Fair Share Contribution	***49.3%***	***61.9%***		
16. Kaiser Rd/Enterprise Way	Baseline	781	791		
	Cumulative No Project	1,360	1,330		
	Costco Alternative Project Trips	712	1,068	X	X
	Cumulative plus Costco Alternative	2,080	2,400		
	Contribution to Cumulative Plus Costco Alternative Volumes	34.2%	44.5%		
	Costco Alternative Fair Share Contribution	***54.8%***	***66.4%***		
17. SR 221 (Napa-Vallejo Highway)/Kaiser Rd	Baseline	4,386	4,556		
	Cumulative No Project	6,150	6,320		
	Costco Alternative Project Trips	800	909	X	X
	Cumulative plus Costco Alternative	6,960	7,230		
	Contribution to Cumulative Plus Costco Alternative Volumes	11.5%	12.6%		
	Costco Alternative Fair Share Contribution	***31.1%***	***34.0%***		
18. Napa Valley Corp. Dr/Latour Ct	Baseline	367	529		
	Cumulative No Project	480	670		
	Costco Alternative Project Trips	33	42		
	Cumulative plus Costco Alternative	510	710		
	Contribution to Cumulative Plus Costco Alternative Volumes	6.5%	5.9%		
	Costco Alternative Fair Share Contribution	***23.1%***	***23.2%***		
19. Napa Valley Corp. Dr/Napa Valley Corp. Way	Baseline	491	812		
	Cumulative No Project	740	1,050		
	Costco Alternative Project Trips	175	225	X	X
	Cumulative plus Costco Alternative	920	1,270		
	Contribution to Cumulative Plus Costco Alternative Volumes	19.0%	17.7%		
	Costco Alternative Fair Share Contribution	***40.8%***	***49.1%***		
20. Napa Valley Corp. Way/SR 221 (Napa-Vallejo Hwy.)	Baseline	4,383	4,380		
	Cumulative No Project	6,580	6,450		
	Costco Alternative Project Trips	276	210	X	X
	Cumulative plus Costco Alternative	6,860	6,670		
	Contribution to Cumulative Plus Costco Alternative Volumes	4.0%	3.1%		
	Costco Alternative Fair Share Contribution	***11.1%***	***9.2%***		
21. Napa Valley Corporate Dr/Bordeaux Way	Baseline	312	700		
	Cumulative No Project	500	880		
	Costco Alternative Project Trips	192	223	X	X
	Cumulative plus Costco Alternative	700	1,100		
	Contribution to Cumulative Plus Costco Alternative Volumes	27.4%	20.3%		
	Costco Alternative Fair Share Contribution	***49.5%***	***55.8%***		
22. Napa Valley Corporate Dr/Anselmo Ct	Baseline	293	669		
	Cumulative No Project	530	930		
	Costco Alternative Project Trips	441	659	X	X
	Cumulative plus Costco Alternative	980	1,590		
	Contribution to Cumulative Plus Costco Alternative Volumes	45.0%	41.4%		
	Costco Alternative Fair Share Contribution	***64.2%***	***71.6%***		
23. SR 12-SR 121/SR 29	Baseline	5,430	5,557		
	Cumulative No Project	6,920	7,980		
	Costco Alternative Project Trips	86	78	X	X
	Cumulative plus Costco Alternative	7,000	8,060		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.2%	1.0%		
	Costco Alternative Fair Share Contribution	***5.5%***	***3.1%***		
24. Napa Valley Corporate Dr/Soscol Ferry Rd	Baseline	289	667		
	Cumulative No Project	430	810		
	Costco Alternative Project Trips	249	436	X	X
	Cumulative plus Costco Alternative	680	1,250		
	Contribution to Cumulative Plus Costco Alternative Volumes	36.6%	34.9%		
	Costco Alternative Fair Share Contribution	***63.7%***	***74.8%***		
25. Soscol Ferry Rd/Devlin Rd	Baseline	737	1,186		
	Cumulative No Project	1,280	1,920		
	Costco Alternative Project Trips	257	445	X	X
	Cumulative plus Costco Alternative	1,550	2,370		
	Contribution to Cumulative Plus Costco Alternative Volumes	**16.6%**	**18.8%**		
	Costco Alternative Fair Share Contribution	*31.6%*	*37.6%*		
26. SR 12-SR 29/SR 221 (Napa-Vallejo Highway)	Baseline	8,226	8,111		
	Cumulative No Project	10,920	12,060		
	Costco Alternative Project Trips	323	335	X	X
	Cumulative plus Costco Alternative	11,250	12,400		
	Contribution to Cumulative Plus Costco Alternative Volumes	2.9%	2.7%		
	Costco Alternative Fair Share Contribution	***10.7%***	***7.8%***		

Napa Pipe SF06-0290.05
Cumulative Contributions
8/31/12

Intersection Name	Scenario	Volumes		Potential Impact? (>50 Trips)	
		Funded Network		Funded Network	
27. Airport Blvd/SR 29-SR 12	Baseline	7,214	7,032		
	Cumulative No Project	10,870	11,500		
	Costco Alternative Project Trips	276	251	X	X
	Cumulative plus Costco Alternative	11,150	11,760		
	Contribution to Cumulative Plus Costco Alternative Volumes	2.5%	2.1%		
	Costco Alternative Fair Share Contribution	***7.0%***	***5.3%***		
28. SR 29/South Kelley Road	Baseline	4,705	4,733		
	Cumulative No Project	7,500	6,320		
	Costco Alternative Project Trips	193	180	X	X
	Cumulative plus Costco Alternative	7,690	6,500		
	Contribution to Cumulative Plus Costco Alternative Volumes	2.5%	2.8%		
	Costco Alternative Fair Share Contribution	***6.5%***	***10.2%***		
29. SR 29/Napa Junction Road	Baseline	4,973	4,507		
	Cumulative No Project	6,750	6,610		
	Costco Alternative Project Trips	193	180	X	X
	Cumulative plus Costco Alternative	6,940	6,790		
	Contribution to Cumulative Plus Costco Alternative Volumes	2.8%	2.7%		
	Costco Alternative Fair Share Contribution	***9.8%***	***7.9%***		
30. SR 29/Donaldson Way	Baseline	5,188	4,264		
	Cumulative No Project	6,330	7,090		
	Costco Alternative Project Trips	194	181	X	X
	Cumulative plus Costco Alternative	6,520	7,280		
	Contribution to Cumulative Plus Costco Alternative Volumes	3.0%	2.5%		
	Costco Alternative Fair Share Contribution	***14.6%***	***6.0%***		
31. SR 29/American Canyon Rd	Baseline	5,377	4,860		
	Cumulative No Project	7,500	9,020		
	Costco Alternative Project Trips	147	137	X	X
	Cumulative plus Costco Alternative	7,650	9,150		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.9%	1.5%		
	Costco Alternative Fair Share Contribution	***6.5%***	***3.2%***		
32. American Canyon Rd/Silver Oak Trail/Broadway St	Baseline	2,141	2,217		
	Cumulative No Project	3,150	4,100		
	Costco Alternative Project Trips	38	35		
	Cumulative plus Costco Alternative	3,190	4,130		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.2%	0.8%		
	Costco Alternative Fair Share Contribution	***3.6%***	***1.8%***		
33. American Canyon Rd/Newell Dr	Baseline	2,412	2,436		
	Cumulative No Project	4,820	4,310		
	Costco Alternative Project Trips	38	35		
	Cumulative plus Costco Alternative	4,860	4,340		
	Contribution to Cumulative Plus Costco Alternative Volumes	0.8%	0.8%		
	Costco Alternative Fair Share Contribution	***1.6%***	***1.8%***		
34. SR 29/SR 37 Westbound Off-Ramp	Baseline	4,507	5,073		
	Cumulative No Project	6,690	7,450		
	Costco Alternative Project Trips	109	102	X	X
	Cumulative plus Costco Alternative	6,810	7,560		
	Contribution to Cumulative Plus Costco Alternative Volumes	1.6%	1.3%		
	Costco Alternative Fair Share Contribution	***4.7%***	***4.1%***		

PRELIMINARY CALCULATIONS FOR HYDROLOGY

Exhibit K.1 - Preliminary Calculations for Hydrology, prepared by Riechers Spence & Associates, dated November 21, 2013

PRELIMINARY CALCULATIONS FOR HYDROLOGY

NAPA PIPE REDEVELOPMENT PROJECT

(Napa Pipe Development Plan)

Prepared By:

Consulting Civil Engineers Riechers & Spence Associates

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November 21, 2013 Job No. 4106029.0

PRELIMINARY CALCULATIONS FOR HYDROLOGY

Table of Contents

SECTION I

Purpose

Evaluate the pre-project and post-project hydrology of the project site to determine approximate pre-project and post-project flows to the existing outfalls.

Analysis of Existing Conditions

The Napa Pipe Redevelopment project is located at 1025 Kaiser Road in an unincorporated area of Napa County. The project is bound by Kaiser Road to the north, Basalt Road to the east, the Napa River to the west, and Bedford Slough / wetlands to the south. The site is also bisected by the Southern Pacific Railroad.

The site was a former industrial pipe fabrication facility and is approximately 154 acres in size. Much of the site is covered with impervious surfaces including asphalt, concrete, compacted gravel and roofs. There are scattered portions of the site covered with vegetation, but these areas are sparse.

There are existing outfalls into the Napa River. There is also existing drainage flowing to the existing diagonal ditch on-site as well as drainage to Bedford Slough to the south of the site and the existing wetlands on the southwest corner of the site.

Historical drainage patterns show the site divided into east and west drainage routes, with most of the west portion draining to the Napa River and the eastern side draining to Basalt Road which eventually drains south to the upper reaches of Bedford Slough. Existing watersheds are shown in Appendix A. The project site is currently below the 100-year floodplain and experiences some flooding during large rain events.

Methodology

National Resources Conservation Service (NRCS) TR-20 was used to model site runoff occurring from a single storm event. TR-20 develops flood hydrographs from runoff and routes the flow through channels and pipes. Input data includes drainage sub-areas, runoff curve numbers (CN), time of concentration (Tc), and rainfall information. CN is an index used to quantify the runoff potential of a drainage area and is based on hydrologic soil group and land use.

Soil classification data, CN and Tc calculations are available in Appendix B. Site hydrographs that show peak flows are available in Appendix C.

Summary of Proposed Development

The proposed drainage design maintains existing drainage patterns on the project site to the maximum extent practicable. Additionally, the drainage design uses the existing drainage outfalls along the Napa River without increasing the existing flow to each outfall during storm events.

As is shown on the Tentative Subdivision Map (TM) the proposed grading design will add between 5 and 7 feet of fill over the entire site to raise the site above the FEMA 100-year flood plain.

The exhibits and calculations within this report are based on a full build-out scenario for the project. The current site plan does not have development on the east side of the tracks with the exception of Costco; however this report shows a worst-case scenario and proves that even a full build-out of the site, perhaps in future years, can accommodate hydrologically.

As shown in this report, all existing outfalls are receiving less flow than pre-project conditions. Overland flow during a 100-year storm event is shown on the TM. Existing drainage patterns are maintained and drainage is flowing to the existing diagonal ditch (to remain) and Bedford Slough, as well as the wetlands in the southwest project corner. A large portion of the site runoff will drain to a new outfall in one of the existing dry docks to avoid construction within the banks of the river.

A portion of the drainage east of the tracks will drain to Basalt Road and the existing storm drain main in the roadway, which eventually outlets to Bedford Slough. The remainder of the area east of the tracks is designed to flow to the pipe network which outlets to the dry dock. The main line in Basalt Road will receive less flow than pre-project conditions. Overland release for this area still heads east and ends up in Bedford Slough.

The proposed storm drain pipe system was designed for post-project flows and calculations are available in a separate report titled "Hydraulics Report for the Proposed Storm Drain Network, Napa Pipe Redevelopment Project".

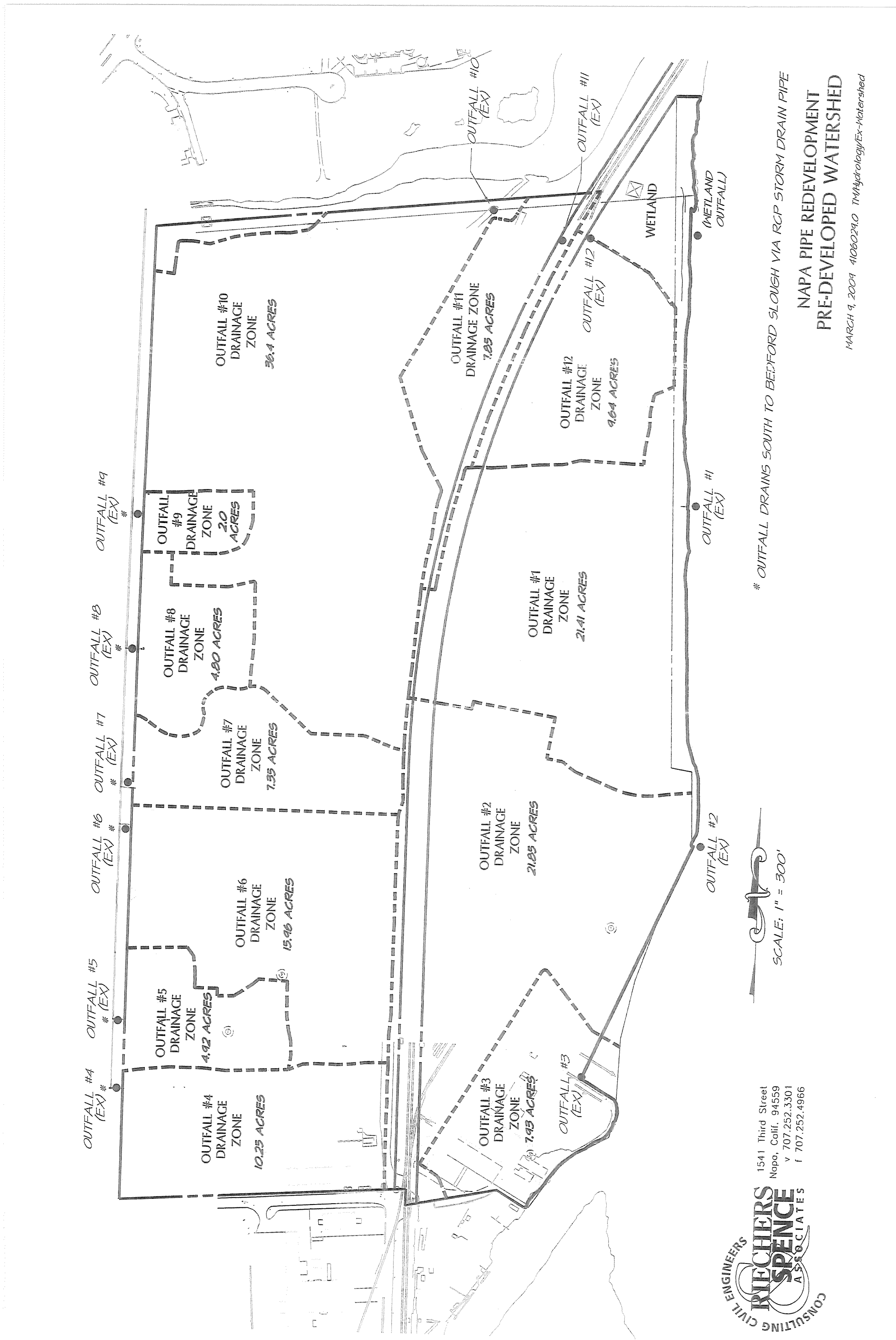
Conclusion

Post-project flows to existing outfalls will not exceed pre-project levels. Historic drainage patterns are maintained to the maximum extent practicable. The project proposes to decrease the existing amount of impervious area by increasing green space. The total runoff leaving the site will be less in the post-project condition than the existing condition. Hydromodification mitigation and storm drain detention systems will not be required for this project since the project drains directly to the Napa River (a tidally influence body of water). A summary of existing and post-project flows for each watershed is available in Appendix D.

SECTION II

Appendix A

Watershed Exhibits


NAPA PIPE REDEVELOPMENT
PRE-DEVELOPED WATERSHED
MARCH 9, 2009 4106029.0 T:\Hydrology\Ex-Watershed
* OUTFALL DRAINS SOUTH TO BEDFORD SLOUGH VIA RCP STORM DRAIN PIPE
SCALE: 1" = 300'
OUTFALL #10 (EX)
OUTFALL #11 (EX)
OUTFALL #12 (EX)
(WETLAND OUTFALL)
WETLAND
OUTFALL #10 DRAINAGE ZONE 36.4 ACRES
OUTFALL #11 DRAINAGE ZONE 7.85 ACRES
OUTFALL #12 DRAINAGE ZONE 9.64 ACRES
OUTFALL #9 (EX)
OUTFALL #9 DRAINAGE ZONE 2.0 ACRES
OUTFALL #1 (EX)
OUTFALL #1 DRAINAGE ZONE 21.41 ACRES
OUTFALL #8 (EX)
OUTFALL #8 DRAINAGE ZONE 4.80 ACRES
OUTFALL #7 (EX)
OUTFALL #7 DRAINAGE ZONE 7.35 ACRES
OUTFALL #6 (EX)
OUTFALL #6 DRAINAGE ZONE 15.96 ACRES
OUTFALL #2 (EX)
OUTFALL #2 DRAINAGE ZONE 21.85 ACRES
OUTFALL #5 (EX)
OUTFALL #5 DRAINAGE ZONE 4.92 ACRES
OUTFALL #4 (EX)
OUTFALL #4 DRAINAGE ZONE 10.25 ACRES
OUTFALL #3 (EX)
OUTFALL #3 DRAINAGE ZONE 7.93 ACRES
RIECHERS SPENCE ASSOCIATES
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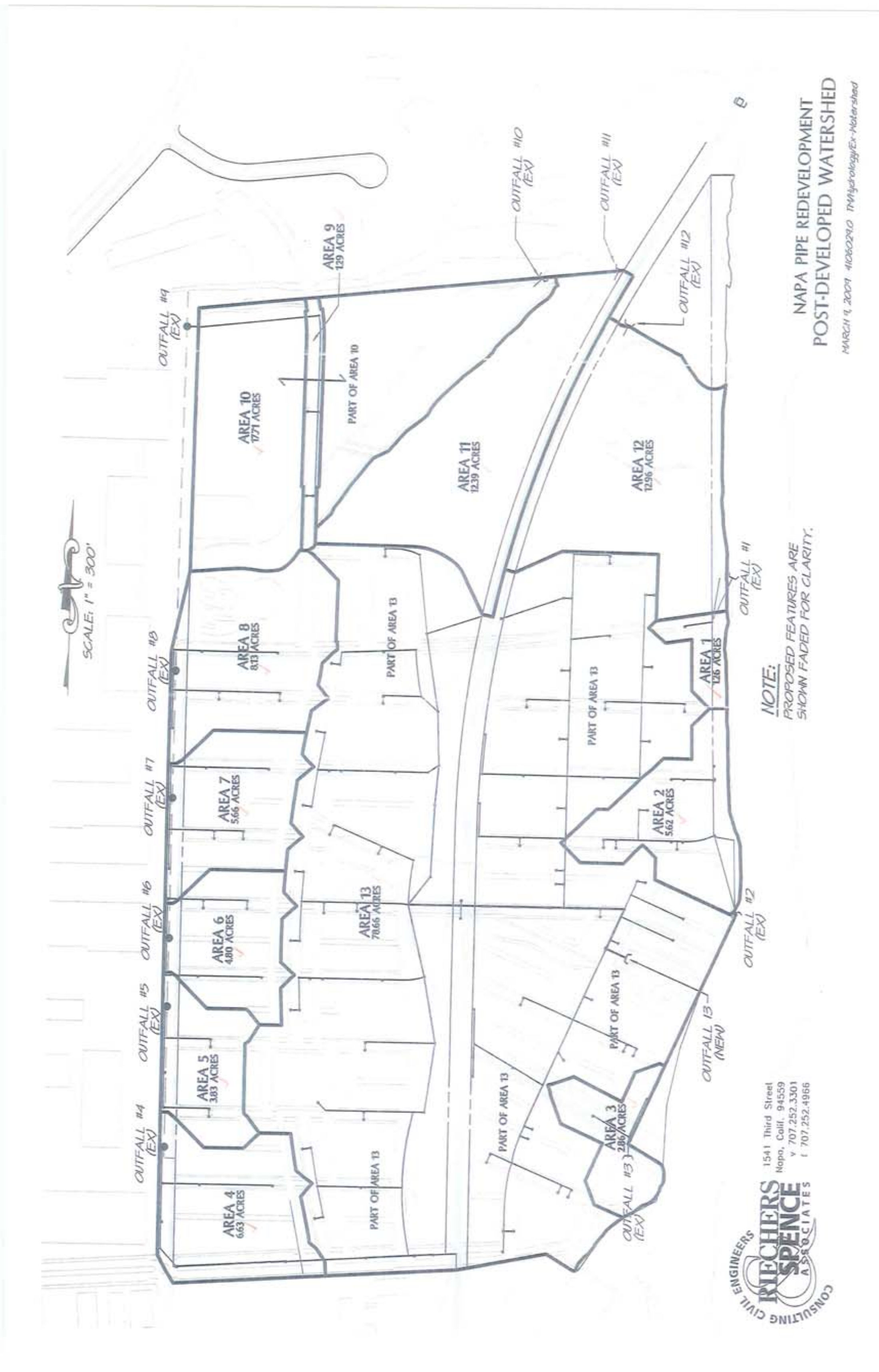
NAPA PIPE REDEVELOPMENT
POST-DEVELOPED WATERSHED
MARCH 9, 2001 4106020.0 TM\Hydrology\Ex-Watershed
SCALE: 1" = 300'
AREA 1 1.26 ACRES
AREA 2 5.62 ACRES
AREA 3 2.86 ACRES
AREA 4 6.63 ACRES
AREA 5 3.83 ACRES
AREA 6 4.80 ACRES
AREA 7 5.66 ACRES
AREA 8 8.13 ACRES
AREA 9 1.29 ACRES
AREA 10 17.71 ACRES
AREA 11 12.39 ACRES
AREA 12 12.96 ACRES
AREA 13 78.66 ACRES
PART OF AREA 13
PART OF AREA 10
OUTFALL #1 (EX)
OUTFALL #2 (EX)
OUTFALL #3 (EX)
OUTFALL #4 (EX)
OUTFALL #5 (EX)
OUTFALL #6 (EX)
OUTFALL #7 (EX)
OUTFALL #8 (EX)
OUTFALL #9 (EX)
OUTFALL #10 (EX)
OUTFALL #11 (EX)
OUTFALL #12 (EX)
OUTFALL 13 (NEW)
NOTE:
PROPOSED FEATURES ARE SHOWN FADED FOR CLARITY.
CONSULTING CIVIL ENGINEERS
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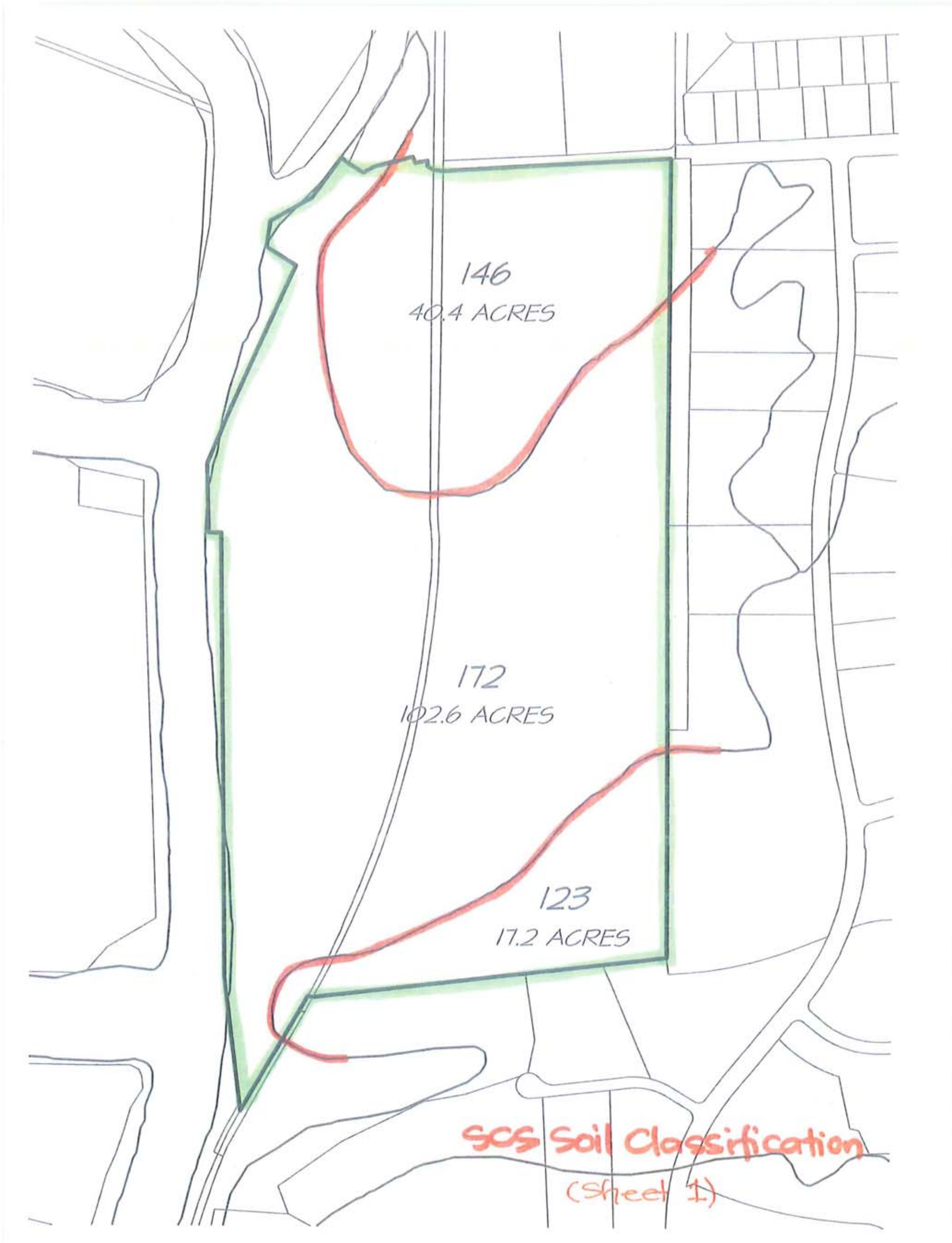
Appendix B

Time of Concentration Calculations


146
40.4 ACRES
172
102.6 ACRES
123
17.2 ACRES
SCS Soil Classification
(Sheet 1)

Runoff is rapid in the less sloping areas and very rapid in the steeper areas. The hazard of erosion is high.

This complex is mainly used for wildlife habitat, watershed, and limited grazing. Some areas near Lake Berryessa are used for recreation. Capability unit VIIe-1 (15); Loamy Upland range site.

Haire series

The Haire series consists of moderately well drained soils on old terraces and alluvial fans. Slope is 0 to 30 percent. Elevation is 20 to 300 feet. These soils formed from alluvium derived from sedimentary rock. The vegetation in uncultivated areas consists of annual grasses and forbs. The mean annual precipitation is 25 to 30 inches, and the mean annual air temperature is 58° to 60° F. Summers are hot and dry, and winters are cool and moist. The frost-free season is 220 to 260 days.

In a representative profile the surface layer is brown and grayish brown medium acid loam 22 inches thick. The subsurface layer is light gray medium acid sandy clay loam 5 inches thick. The subsoil is pale brown very strongly acid clay to a depth of 45 inches. Below this, it is pale yellow very strongly acid sandy clay to a depth of 60 inches.

Permeability is very slow. The effective rooting depth is mainly 60 inches or more, but it is 20 to 30 inches for most locally grown root-sensitive crops. The available water capacity is 3 to 6 inches.

Haire soils are mainly used for dryland and irrigated pasture. Some areas are used for small prune orchards, but many of these are being planted to varietal grapes. Some other areas are used for range.

Representative profile of Haire loam, 0 to 2 percent slopes, about 600 feet south and 300 feet east of first right turn on Green Island Road about 1⅛ miles west of State Highway 29, SE¼NW¼, sec. 14, T. 4 N., R. 4 W.:

Ap1—0 to 6 inches, brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine interstitial and tubular pores; medium acid (pH 5.6); abrupt wavy boundary.

Ap2—6 to 15 inches, brown (10YR 5/3) loam and common fine distinct dark brown (7.5YR 3/2) mottles, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common fine and few coarse interstitial and tubular pores; medium acid (pH 6.0); clear smooth boundary.

A13—15 to 22 inches, grayish brown (10YR 5/2) loam and common, fine, faint dark yellowish brown (10YR 4/4) mottles, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine interstitial pores, more porous than Ap2; medium acid (pH 6.0); clear smooth boundary.

A2—22 to 27 inches, light gray (10YR 7/2) sandy clay loam, mixed light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and plastic; common very fine roots; common fine interstitial pores; medium acid (pH 6.0); abrupt wavy boundary.

B2t—27 to 45 inches, pale brown (10YR 6/3) clay, dark grayish brown (2.5Y 4/2) moist; massive; very hard, extremely firm, very sticky and very plastic; common interstitial pores; many thick clay films lining pores and as bridges; very strongly acid (pH 5.0); clear smooth boundary.

B3t—45 to 60 inches, pale yellow (5Y 7/3) sandy clay, yellowish brown (10YR 5/4) and pale brown (10YR 6/3) moist; massive; slightly hard, friable, very sticky and very plastic; few thick clay films with clay mainly as bridges; very strongly acid (pH 5.0).

The A horizon is grayish brown or brown (10YR 5/2, 5/3) loam or clay loam. Reaction is medium acid or strongly acid.

The B2t horizon ranges from very pale brown to light yellowish brown (10YR 7/3, 7/4, 6/2, and 6/4). Reaction is medium acid to very strongly acid. The B2t horizon is underlain by strongly acid or very strongly acid layers of very gravelly, very cobbly, or stony clay loam or sandy clay, some of which are semicemented.

145—Haire loam, 0 to 2 percent slopes. This nearly level soil is on old low terraces and alluvial fans. It has the profile described as representative for the series.

Included with this soil in mapping were small areas of Clear Lake, Cole, Pleasanton, and Reyes soils. Also included were areas of soils where subsoiling has caused mixing of the surface layer with material from the subsoil and areas of soils that have a surface layer of sandy loam.

Runoff is slow. There is little or no hazard of erosion.

The soil is used for pasture, but much of the acreage is being planted to vineyards. Capability unit IIIs-3 (14); Claypan range site.

√**146—Haire loam, 2 to 9 percent slopes.** This gently sloping to moderately sloping soil is on old terraces and alluvial fans.

Included with this soil in mapping were small areas of Clear Lake, Fagan, Diablo, and Dibble soils. Also included were areas of soils that have a surface layer of sandy loam and areas of soils that the similar to this Haire soil but that are redder throughout the profile.

Runoff is slow to medium. The hazard of erosion is slight.

This soil is mainly used for grazing, but some of these areas are being planted to varietal wine grapes. Capability unit IIIe-3 (14); Claypan range site.

147—Haire clay loam, 0 to 2 percent slopes. This nearly level soil is on old low terraces and alluvial fans.

Included with this soil in mapping were small areas of Cole and Reyes soils. Also included were areas of soils where subsoiling has caused mixing of the surface layer with material from the subsoil.

Runoff is slow. There is no hazard of erosion.

This soil is mainly used for pasture, but some of these areas are being planted to varietal wine grapes. Capability unit IIIs-3 (14); Claypan range site.

SCS Soil Classification
(Sheet 2)

The Bt horizon is mainly light yellowish brown to pink (10YR 5/3, 5/4, 6/3, 6/4, 7/3, and 7/4 and 7.5YR 5/4, 6/4, and 7/4) clay loam, but it is clay in places at a depth of more than 33 inches. Reaction is medium acid. Depth to the very gravelly substratum is 40 to 60 inches.

122—Coombs gravelly loam, 0 to 2 percent slopes. This nearly level soil is on old low terraces and old alluvial fans.

Included with this soil in mapping were small areas of Clear Lake, Haire, Bale, and Yolo soils and a reddish soil that has a heavy clay subsoil. Also included were areas of soils that have a semicemented conglomerate below the subsoil and areas of soils near Hagen Road that are underlain by rhyolytic tuff.

Runoff is slow. The hazard of erosion is slight.

This soil is mainly used for prune orchards, but the orchards are being converted to vineyards. Capability unit IIIs-3 (14).

123—Coombs gravelly loam, 2 to 5 percent slopes. This gently sloping soil is on old terraces and old alluvial fans. It has the profile described as representative for the series.

Included with this soil in mapping were small areas of soils that have slopes of as much as 9 percent and small areas of Clear Lake, Cole, Haire, and Yolo soils. Also included were few small areas of a soil in the Big Ranch Road area that have a red clay subsoil and areas of soils near Hagen Road that are underlain by rhyolytic tuff.

Runoff is slow. The hazard of erosion is slight.

This soil is mainly used for prune orchards, but it is being converted to vineyards. Much of the area is used for homesites. Capability unit IIIe-3 (14).

Cortina series

The Cortina series consists of excessively drained soils on flood plains and alluvial fans. Slope is 0 to 5 percent. Elevation is 100 to 500 feet. These soils formed from recent stratified alluvium. The vegetation consists of willows and water grasses. The mean annual precipitation is 30 to 35 inches, and the mean annual temperature is 61° to 64° F. Summers are hot and dry, and winters are cool and moist. The frost-free season is 230 to 260 days.

In a representative profile the surface layer is about 21 inches thick. It is pale brown, neutral very gravelly loam in the upper 11 inches and light brownish gray, mildly alkaline very gravelly sandy loam in the lower 10 inches. The underlying material to a depth of 60 inches or more is stratified, light brownish gray, mildly alkaline very gravelly loamy sand.

Permeability is rapid. The effective rooting depth is 60 inches or more. Available water capacity is 2 to 5 inches.

Cortina soils are used mostly for vineyards. Some areas are used for prune orchards.

Representative profile of Cortina very gravelly loam, 0 to 5 percent slopes, 50 feet south of intersection of Silverado Trail and State Highway 128, SE¼NW¼ sec. 3, R. 5 W., T. 7 N.:

Ap—0 to 11 inches, pale brown (10YR 6/3) very gravelly loam, dark grayish brown (10YR 4/2) moist; massive; soft, friable, nonsticky and nonplastic; many very fine roots; many very fine and fine interstitial pores; 50 percent gravel; neutral (pH 7.0); clear smooth boundary.

A12—11 to 21 inches, light brownish gray (10YR 6/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, friable, nonsticky and nonplastic; many very fine roots; many very fine and fine interstitial pores; 50 percent gravel; mildly alkaline (pH 7.5); clear wavy boundary.

IIC1—21 to 32 inches, light brownish gray (10YR 6/2) very gravelly loamy sand, dark grayish brown (10YR 4/2) moist; massive; soft, friable, nonsticky and nonplastic; many very fine and few medium roots; many very fine and fine interstitial pores; 70 percent gravel; mildly alkaline (pH 7.5); clear wavy boundary.

IIC2—32 to 60 inches; light brownish gray (10YR 6/2) very gravelly loamy sand, dark grayish brown (10YR 4/2) moist; massive; soft, friable, nonsticky and nonplastic; many very fine and few medium roots; many very fine and fine interstitial pores; 80 percent gravel; mildly alkaline (pH 7.5).

The A horizon is pale brown, brown, light brownish gray, grayish brown, or dark grayish brown (10YR 6/3, 6/2, 5/2, 5/3, and 4/2) very gravelly sandy loam, very gravelly loam, or very stony loam. Reaction is slightly acid to mildly alkaline. The gravel content ranges from 50 to 60 percent.

The IIC horizon is light brownish gray or brown (10YR 6/2 and 5/3) very gravelly loamy sand or very stony loam. Reaction is slightly acid to moderately alkaline. The coarse-fragment content ranges from 50 to 90 percent.

124—Cortina very gravelly loam, 0 to 5 percent slopes. This nearly level to gently sloping soil is on flood plains. It has the profile described as representative for the series.

Included with this soil in mapping were small areas of Bale and Yolo soils and areas of gravel deposits adjacent to waterways.

Runoff is slow. The hazard of erosion is slight.

This soil is used for vineyards and orchards. Capability unit IVs-4 (14).

125—Cortina very stony loam, 0 to 5 percent slopes. This nearly level to gently sloping soil is on alluvial fans. It has a profile similar to the one described as representative for the series, but stones larger than 10 inches are throughout the profile.

Included with this soil in mapping were small areas of of Bale and Yolo soils and Riverwash.

Runoff is slow. The hazard of erosion is slight.

This soil is mainly used for pasture. Some of the acreage is being converted to vineyards. Capability unit IVs-4 (14).

SCS Soil Classification
(Sheet 3)

strong hydrogen sulfide odor at a depth of more than 30 inches.

172—**Reyes silty clay loam.** This nearly level soil is in basins and on tidal flats. It has the profile described as representative for the Reyes series.

Included with this soil in mapping were small areas of Clear Lake and Haire soils. Also included were small areas of soils that have a loam or silt loam overwash and areas of saline soils.

Runoff is slow. The hazard of erosion is slight.

This soil has a fluctuating water table, but the water table is at a depth of 2 to 5 feet during the dry part of the year and is at a depth of less than 2 feet during winter and early in spring.

This soil is used for oats, hay, and grain where the areas are diked. Capability unit IVw–9 (14).

173—**Reyes silty clay loam, salt ponds.** This soil has been diked for use as evaporation ponds for salt production. The ponds are along tidal flats and basins adjacent to San Pablo Bay. Capability unit VIIIw–1 (14).

Riverwash

174—**Riverwash.** These miscellaneous areas are in active stream channels, on flood plains, and adjacent to drainageways. Slope is 0 to 5 percent. Elevation is 200 to 1,500 feet. The areas are inundated during periods of waterflow and are subject to constant deposition and removal of material. Vegetation consists of occasional willows, water grasses, and some brush.

Riverwash consists of erratically stratified layers of water-deposited sand, gravel, stones, and cobbles. Layers of sandy loam and silt loam are deposited for short periods but are subject to intermittent scouring and removal. Thickness of the strata ranges from 2 to 30 inches. Reaction is neutral or mildly alkaline. The organic matter content varies from stratum to stratum but is common low.

Included with Riverwash in mapping were small areas of Cortina soils.

Runoff is slow. The hazard of erosion is slight to very severe, depending on water velocity.

Riverwash is used as a source of sand and gravel. It is almost devoid of vegetation and has no agricultural use. Capability unit VIIIw–1 (14).

Rock outcrop

175—**Rock outcrop** consists of ridges of igneous bedrock and of outcrops of sandstone and shale in the Blue Ridge area bordering Yolo County. The areas are more than 90 percent Rock outcrop and less than 10 percent areas of soil material that is less than 6 inches deep. The vegetation consists of small shrubs and a few stunted trees in cracks between lichen-covered rocks.

Runoff is very rapid. The hazard of erosion is high.

This miscellaneous area is used for watershed, wildlife habitat, and recreation. Capability unit VIIIs–1 (15).

176—**Rock outcrop-Hambright complex, 50 to 75 percent slopes.** This complex consists of areas of Rock outcrop and soils on south-facing slopes. Elevation is 1,000 to 3,000 feet. The areas of Rock outcrop and soils are so intermingled that it was not practical to separate them at the scale used in mapping. The soils formed in material weathered from fine grained basic igneous material.

This complex is about 60 percent Rock outcrop, 30 percent Hambright soils, and 10 percent Guenoc and Kidd soils. Rock outcrop is in areas 1 to 5 acres in size. It consists of basic igneous boulders, stones, and outcrops.

Runoff is very rapid. The hazard of erosion is high.

This complex is used for watershed and wildlife habitat. Capability unit VIIIs–1 (15).

177—**Rock outcrop-Kidd complex, 50 to 75 percent slopes.** This complex consists of areas of Rock outcrop and soils on south-facing slopes. Elevation is 1,000 to 3,000 feet. The areas of Rock outcrop and soils are so intermingled that it was not practical to map them separately at the scale used in mapping. The soils formed in material weathered from basic igneous rock and rhyolite.

This complex is about 70 percent Rock outcrop, 25 percent Kidd soils, and 5 percent Hambright, Boomer, and Forward soils. Rock outcrop is in areas 1 to 5 acres in size. It consists of basic igneous boulders and massive rhyolitic escarpments, stones, and outcrops.

Runoff is rapid. The hazard of erosion is very high.

This complex is used for wildlife habitat and watershed. Capability unit VIIIs–1 (15).

Sobrante series

The Sobrante series consists of well drained soils on uplands. Slope is 5 to 50 percent. Elevation is 400 to 2,000 feet. These soils formed in material weathered from sandstone. The vegetation is mostly annual grasses, scattered oaks, and a few digger pine. The mean annual precipitation is 25 to 35 inches, and the mean annual temperature is 59° to 62° F. Summers are hot and dry, and winters are cool and moist. The frost-free season is 220 to 260 days.

In a representative profile the surface layer is brown, slightly acid loam 6 inches thick. The subsoil is reddish yellow, light brown, and pink, medium acid clay loam 24 inches thick. Massive sandstone is at a depth of 30 inches.

Permeability is moderate. The effective rooting depth is 25 to 40 inches. Available water capacity is 4 to 6 inches.

Sobrante soils are used mostly for grazing. Some small areas are used for recreation and wildlife habitat.

Representative profile of Sobrante loam, 30 to 50 percent slopes, 5,400 feet north on Chiles Valley Road from intersection with Pope Canyon Road and 100 feet west of Chiles Valley Road, NW¼SE¼ sec. 21 (projected), T. 9 N., R. 5 W.:

A11—0 to 4 inches, brown (7.5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; strong fine and medium granular structure; soft, friable, slightly sticky and slightly plastic; few coarse and many very fine and fine roots; many fine and medium tubular pores; slightly acid (pH 6.5); clear wavy boundary.

SCS Soil Classification
(Sheet 4)

TABLE 12.—*Soil and water features*

[Absence of an entry indicates the feature is not a concern. See text for descriptions of symbols and such terms as "rare" and "brief." The symbol > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			In	
Aiken:									
100, 101, 102	B	None			>6.0			40-60	Hard
Bale:									
103, 104, 105	C	Rare			>4.0	Apparent	Nov-Mar	>60	
[1]106:									
Bale loam part	C	Rare			2.0-4.0	Apparent	Nov-Mar	>60	
Bale clay loam part.	C	Rare			2.0-4.0	Apparent	Nov-Mar	>60	
Boomer:									
107, 108, 109	B	None			>6.0			40-60	Rippable
[1]110, [1]111:									
Boomer part	B	None			>6.0			40-60	Rippable
Forward part	C	None			>6.0			20-40	Rippable
Felta part	B	None			>6.0			>60	
Bressa:									
[1]112, [1]113, [1]114, [1]115:									
Bressa part	C	None			>6.0			30-40	Rippable
Dibble part	C	None			>6.0			20-40	Rippable
Clear Lake:									
116	D	None			>6.0			>60	
117	D	Frequent	Brief	Nov-Mar	3.0-6.0	Apparent	Dec-Mar	>60	
Cole:									
118, 119	C	None			3.0-5.0	Apparent	Feb-Apr	>60	
Contra Costa:									
120, 121	C	None			>6.0			25-40	Rippable
Coombs:									
122, 123	B	None			>6.0			>60	
Cortina:									
124, 125	A	None			>6.0			>60	
Diablo:									
126, 127, 128, 129	D	None			>6.0			40-80	Rippable
Egbert:									
130	C	Occasional	Very long	Jan-Dec	0.5-3.0	Apparent	Jan-Dec	>60	
Fagan									
131, 132, 133, 134	C	None			>6.0			40-60	Rippable
Felton:									
135, 136, 137	C	None			>6.0			30-40	Rippable
Forward:									
138, 139, 140	C	None			>6.0			20-40	Rippable
[1]141:									
Forward part	C	None			>6.0			20-40	Rippable
Kidd part	D	None			>6.0			12-15	Rippable
Guenoc:									
142	C	None			>6.0			25-40	Rippable
[1]143, [1]144:									
Guenoc part	C	None			>6.0			25-40	Rippable
Rock outcrop part.									
Haire:									
145, 146, 147, 148, 149, 150	C	None			>6.0			>60	
Hambright:									
[1]151, [1]152:									
Hambright part	D	None			>6.0			10-20	Hard
Rock outcrop part.									
Henneke:									
153, 154	D	None			>6.0			10-20	Hard
Kidd:									
155, 156	D	None			>6.0			12-15	Rippable
Lodo:									
[1]157:									
Lodo part	D	None			>6.0			6-20	Rippable
Maymen part	D	None			>6.0			10-16	Hard
Felton part	C	None			>6.0			30-40	Rippable
Los Gatos:									
158, 159, 160	C	None			>6.0			20-40	Hard

See footnote at end of table.

HYDROLOGIC SOILS GROUP (Sheet 1)

TABLE 12.—*Soil and water features*—Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			*In*	
Maxwell:									
161	D	None			>6.0			>60	
Maymen:									
[1]162:									
Maymen part	D	None			>6.0			10–16	Hard
Los Gatos part	C	None			>6.0			20–40	Hard
[1]163:									
Maymen part	D	None			>6.0			10–16	Hard
Millsholm part	D	None			>6.0			12–20	Hard
Lodo part	D	None			>6.0			6–20	Rippable
Millsholm:									
164, 165	D	None			>6.0			10–20	Hard
Montara:									
166, 167	D	None			>6.0			10–15	Hard
Perkins:									
168, 169	C	None			>6.0			>60	
Pleasanton:									
170, 171	B	None			>6.0			>60	
Reyes:									
172	C/D	Frequent	Very brief	Jan-Dec	0–2.0	Apparent	Oct-May	>60	
173	D	Frequent	Very long	Jan-Dec	0–1.0	Apparent	Jan-Dec	>60	
Riverwash:									
174	D	Frequent	Very long	Jan-Dec	0–3.0	Apparent	Jan-Dec	>60	
Rock outcrop:									
175.									
[1]176:									
Rock outcrop part.									
Hambright part	D	None			>6.0			10–20	Hard
[1]177:									
Rock outcrop part.									
Kidd part	D	None			>6.0			12–15	Rippable
Sobrante:									
178, 179	C	None			>6.0			25–40	Hard
Tehama:									
180	C	None			>6.0			>60	
Yolo:									
181, 182	B	None			>6.0			>60	

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

ence of bedrock or a cemented pan in the upper 5 or 6 feet of the soil, by subsidence, or by frost action.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. 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 to deep, moderately well drained to 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 that have a layer that impedes the downward movement of water or soils that have 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 clay soils that have a high shrink-swell potential, soils that have a permanent 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.

Flooding is rated in general terms that describe the frequency, duration, and period of the year when flooding is most likely. The ratings are based on evidences in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about flood-

HYDROLOGIC SOILS GROUP (Sheet 2)

Table 2-2a Runoff curve numbers for urban areas [1]

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

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

(EXISTING)
RUNOFF CURVE NUMBER

Worksheet: Runoff Curve Number

Project	Napa Pipe Redevelopment	By	Ray	Date	3/3/2009
Location	Napa, California	Checked		Date	
Subshed name	Existing Watershed	Check one:	☑ Present	☐ Developed	

RUNOFF CURVE NUMBER

Soil name and hydrologic group (SCS book)	Cover description (cover type, treatment and hydrogic condition; percent impervious)	CN (1) (Table 2-2)	Area ☑ acres ☐ mi2 ☐ %	Product of CN x Area
123-B	Industrial	88	17.20	1513.60
146-C	Industrial	91	40.40	3676.40
172-C	Industrial	92	102.60	9439.20
		TOTAL:	160.20	14629.20

(1) Use only one CN source per line

CN (weighted) = total product / total area = 14629.20 / 160.20 = 91.32 ; USE CN **91**

Table 2-2a Runoff curve numbers for urban areas [1]

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

Handwritten annotations: PARK PROP (arrow to Good condition); C/D = 77; OTHERS PROP (arrow to 1/8 acre); C/D = 91

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

(PROPOSED)
RUNOFF CURVE NUMBER

Worksheet: Runoff Curve Number

Project	Napa Pipe Redevelopment	By	Ray	Date	3/9/2009
Location	Napa, California	Checked		Date	
Subshed name	Proposed Watershed	Check one:	☐ Present		☑ Developed

RUNOFF CURVE NUMBER

Soil name and hydrologic group (SCS book)	Cover description (cover type, treatment and hydrogic condition; percent impervious)	CN (1) (Table 2-2)	Area ☑ acres ☐ mi2 ☐ %	Product of CN x Area
123-B	1/8 acre or less (townhouses)	85	16.04	1363.40
146-C	1/8 acre or less (townhouses)	90	29.85	2686.50
172-C/D	1/8 acre or less (townhouses)	91	84.21	7663.11
123-B	Park (Good Condition)	61	1.16	70.76
146-C	Park (good Condition)	74	10.55	780.70
172-C/D	Park (Good Condition)	77	18.39	1416.03
		TOTAL:	160.20	13980.50

(1) Use only one CN source per line

CN (weighted) = total product / total area = 13980.50 / 160.20 = 87.27 ; USE CN **87**

Sheet flow

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

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

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

1 The n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

USE
USE

TABLE 3-1
ROUGHNESS COEFFICIENTS
(for Ex. Surfaces)

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

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

where:

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

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

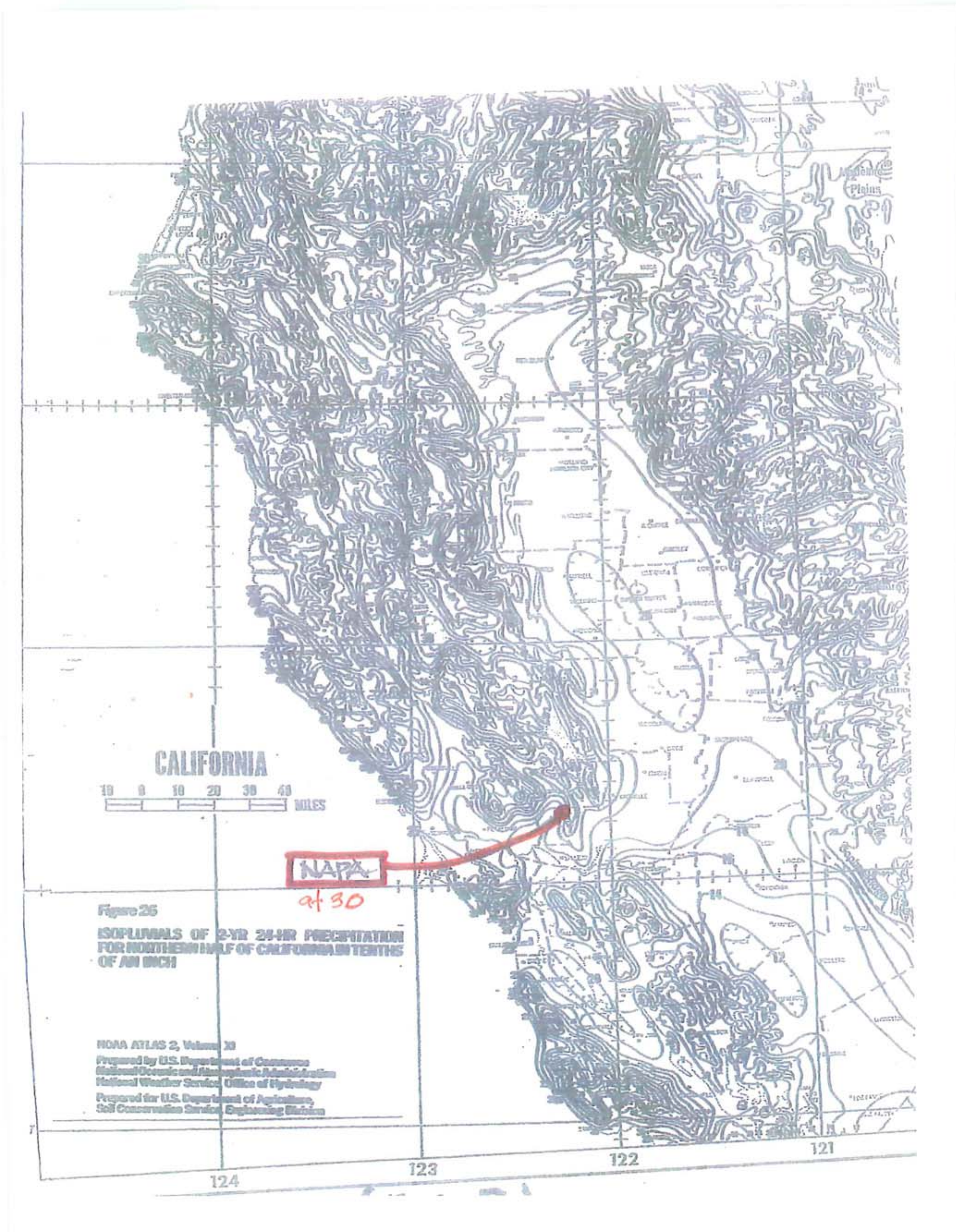
Shallow concentrated flow

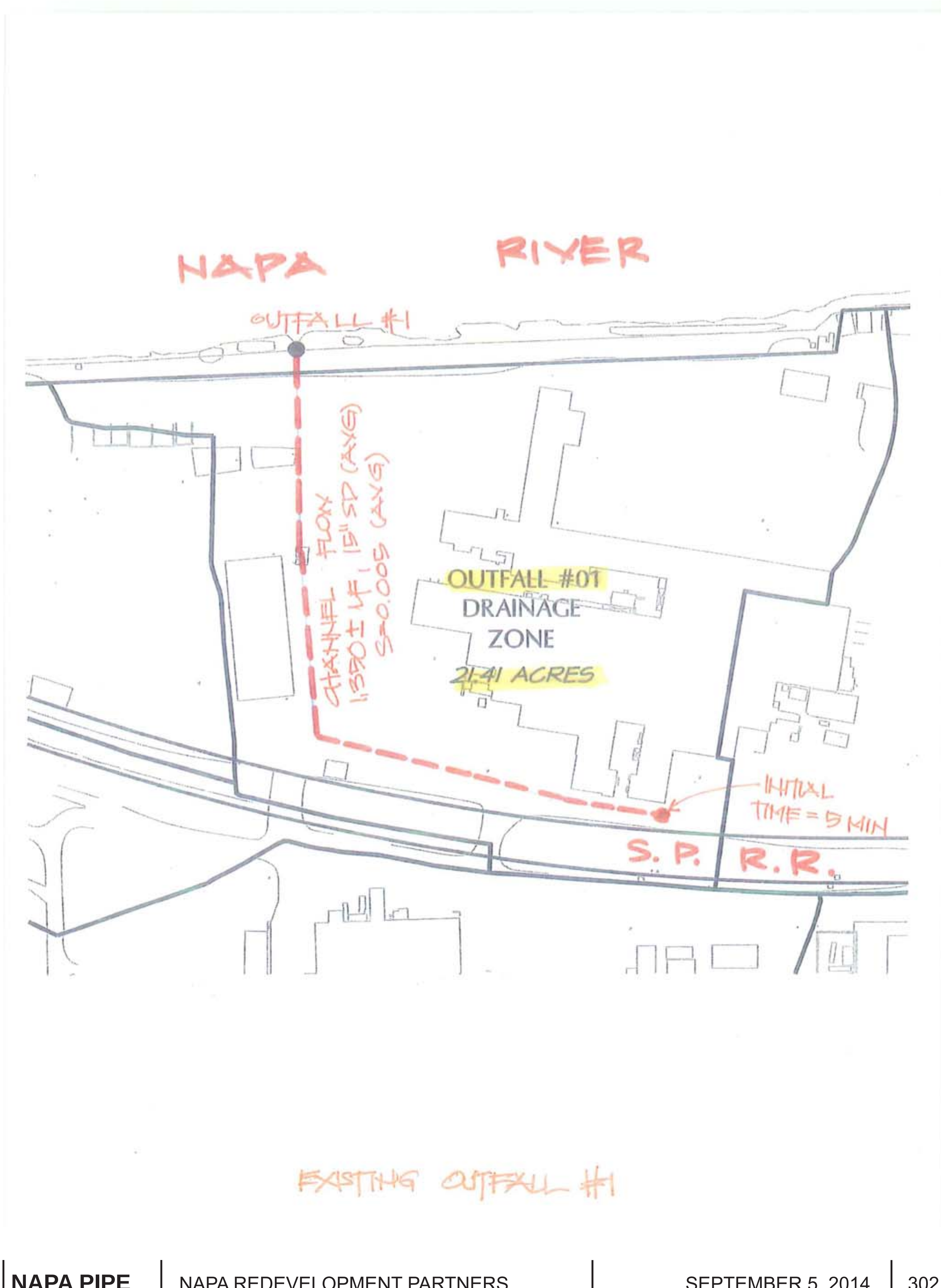
After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix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

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

Open channels

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


CALIFORNIA
10 0 10 20 30 40 MILES
NAPA
9+30
Figure 26
ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION FOR NORTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH
124
123
122
121


NAPA RIVER
OUTFALL #1
CHANNEL FLOW
1,390± LF, 15" SD (AVG)
S=0.005 (AVG)
OUTFALL #01
DRAINAGE
ZONE
21.41 ACRES
INITIAL
TIME = 5 MIN
S. P. R.R.
EXISTING OUTFALL #1

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Ex Watershed - Outfall 1	Check one: ☑ Present ☐ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

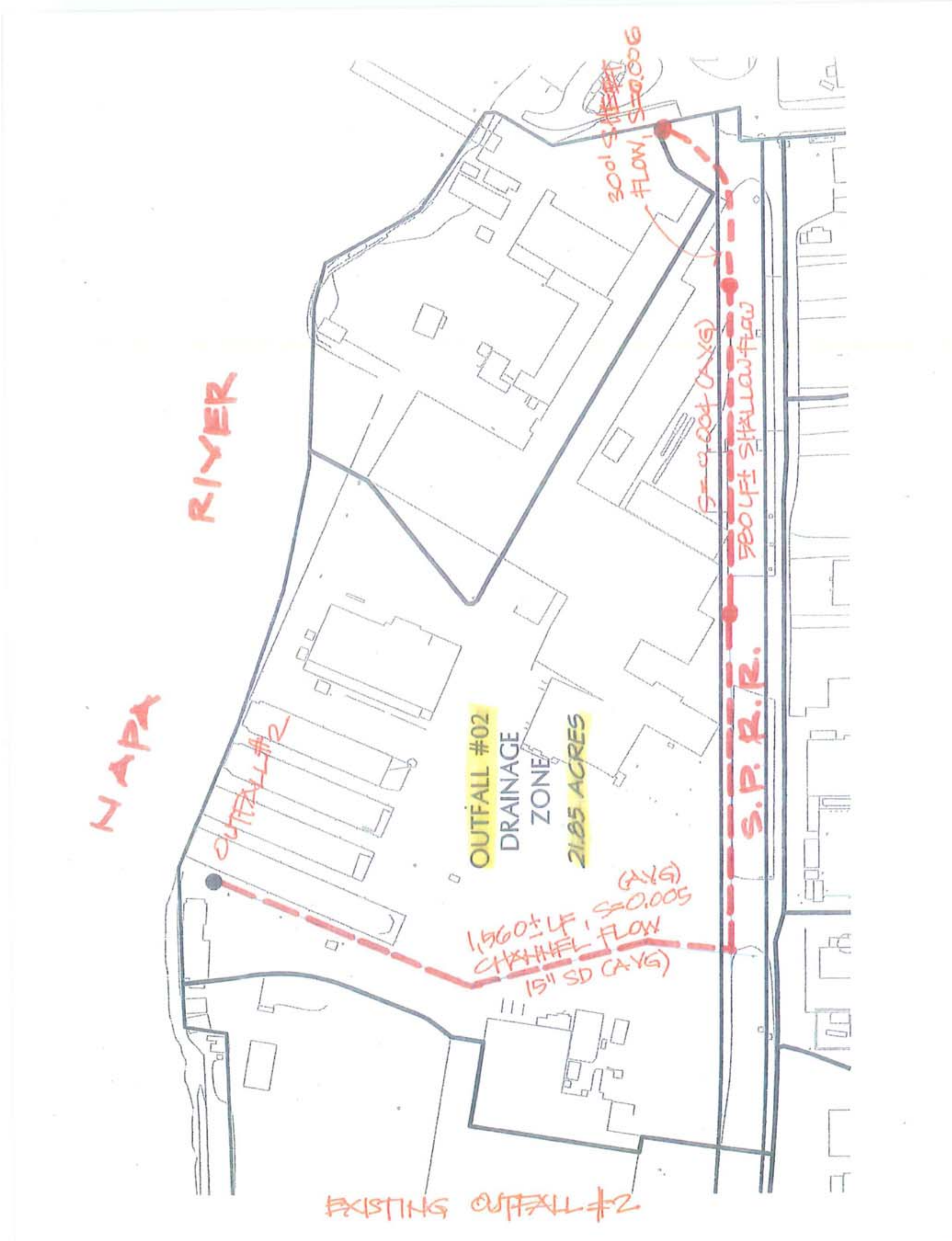
Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes		
2. Manning's roughness coefficient, n (table3-1)	0.15	(Roof		
3. Flow length, L (total L, 300 ft) ... ft	40	to		
4. Two-year 24-hour rainfall, P_2 ... in	3	Inlet)		
5. Land slope, s ... ft/ft	0.0186			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\; s^{0.4}}$ Compute T_t ... hr	0.0834	+	=	0.0834

SHALLOW CONCENTRATED FLOW

Segment ID				
7. Surface description (paved or unpaved)				
8. Flow length, L ... ft				
9. Watercourse slope, s ... ft/ft				
10. Average velocity, V (figure 3-1) ... ft/sec				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t ... hr		+	=	

CHANNEL FLOW

Segment ID	2			
12. Cross sectional flow area, a ... ft²	1.2272			
13. Wetted perimeter, p_w ... ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ... ft	0.3125			
15. Channel slope, s ... ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V . ft/sec	3.7322			
18. Flow length, L ... ft	1,350			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t ... hr	0.1005	+	=	0.1005
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) ... hr				0.1839


NAPA RIVER
300' SHEET FLOW, S=0.006
S=0.004 (A.Y.G)
580 LF± SHALLOW FLOW
OUTFALL #02
DRAINAGE
ZONE
21.85 ACRES
S.P.R.R.
OUTFALL #2
1,560± LF, S=0.005 (A.Y.G)
CHANNEL FLOW
15" SD (A.Y.G)
EXISTING OUTFALL #2

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Ex Watershed - Outfall 2	Check one:	☑ Present	☐ Developed
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one:	☑ Tc	☐ Tt through subarea

SHEET FLOW (applicable to Tc only)

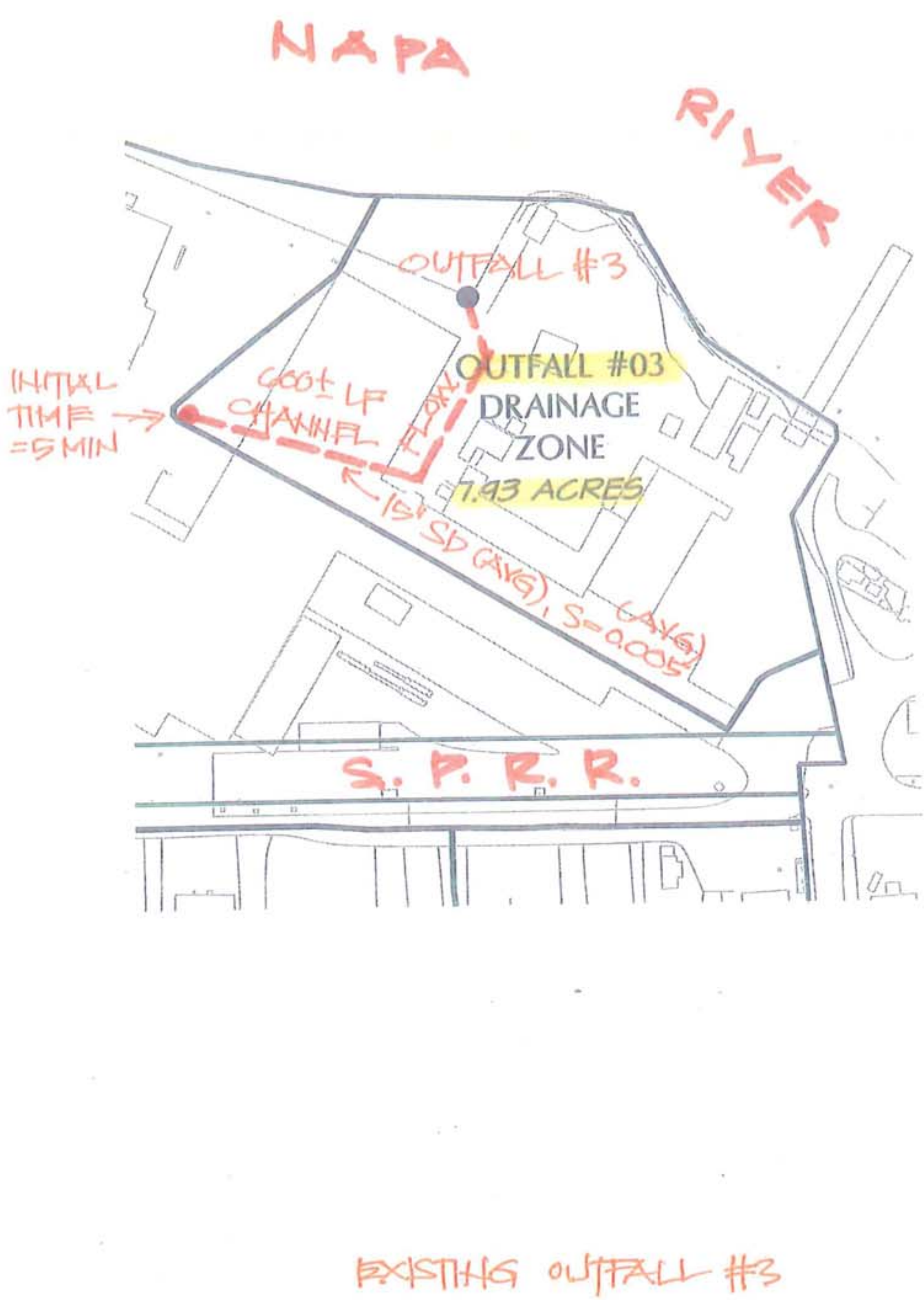
Segment ID	1			
1. Surface description (table 3-1)	Paved Area			
2. Manning's roughness coefficient, n (table3-1)	0.011			
3. Flow length, L (total L, 300 ft) . . . ft	300			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.006			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\; s^{0.4}}$ Compute T_t . . . hr	0.0813	+	=	0.0813

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L . . . ft	580			
9. Watercourse slope, s . . . ft/ft	0.004			
10. Average velocity, V (figure 3-1) . . . ft/sec	1.0204			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr	0.1579	+	=	0.1579

CHANNEL FLOW

Segment ID	3			
12. Cross sectional flow area, a . . . ft^2	1.2272			
13. Wetted perimeter, p_w . . . ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec	3.7322			
18. Flow length, L . . . ft	1,560			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr	0.1161	+	=	0.1161
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.3553


NAPA
RIVER
OUTFALL #3
OUTFALL #03
DRAINAGE
ZONE
7.93 ACRES
INITIAL
TIME
=5 MIN
600± LF
CHANNEL
FLOW
S. P. R. R.
EXISTING OUTFALL #3

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Ex Watershed - Outfall 3	Check one: ☑ Present ☐ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes		
2. Manning's roughness coefficient, n (table3-1)	0.15	(Roof		
3. Flow length, L (total L, 300 ft) . . . ft	40	to		
4. Two-year 24-hour rainfall, P_2 . . . in	3	Inlet)		
5. Land slope, s . . . ft/ft	0.0186			
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t . . . hr	0.0834	+	=	0.0834

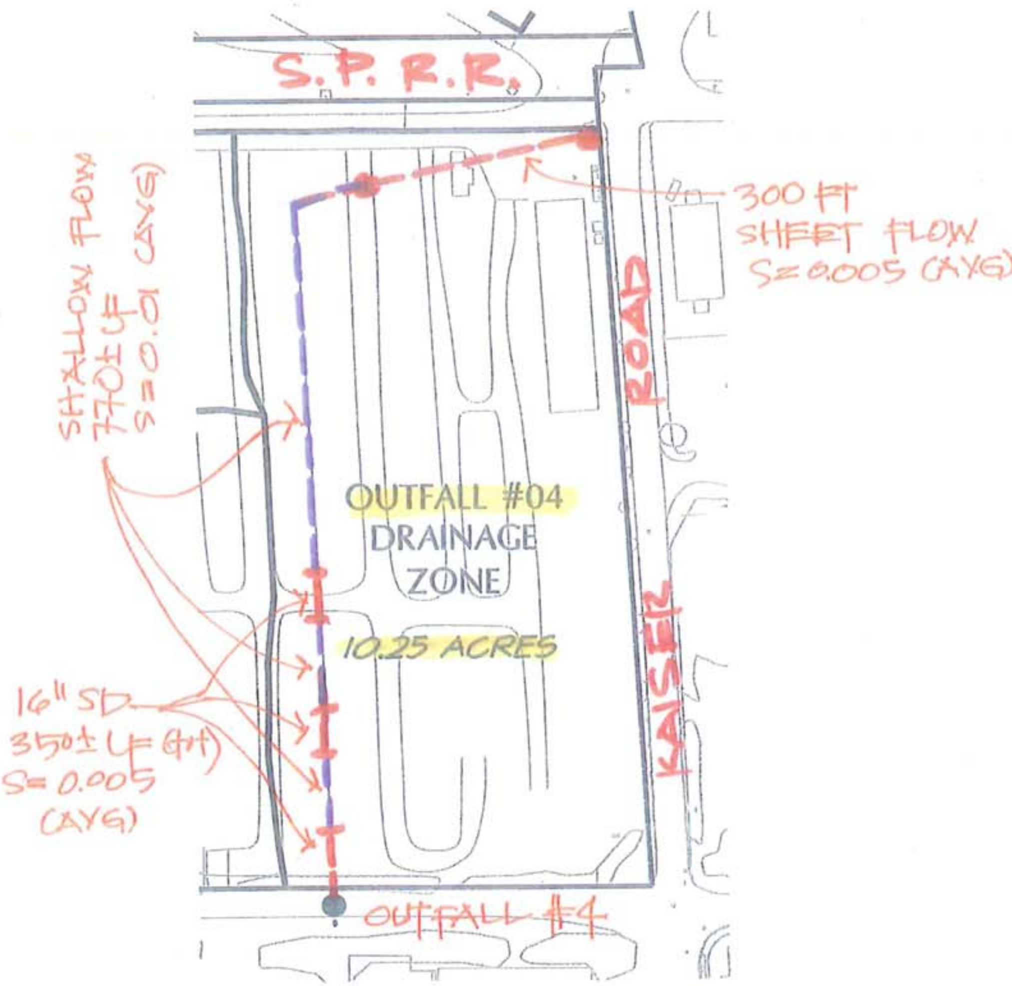
SHALLOW CONCENTRATED FLOW

Segment ID				
7. Surface description (paved or unpaved)				
8. Flow length, L . . . ft				
9. Watercourse slope, s . . . ft/ft				
10. Average velocity, V (figure 3-1) . . . ft/sec				
11. $T_t = \frac{L}{3600\ V}$ Compute T_t . . . hr		+	=	

CHANNEL FLOW

Segment ID	2			
12. Cross sectional flow area, a . . . ft²	1.2272			
13. Wetted perimeter, p_w . . . ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V . ft/sec	3.7322			
18. Flow length, L . . . ft	600			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t . . . hr	0.0447	+	=	0.0447
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.1281

USE 10 MIN = 0.1667



EXISTING OUTFALL # 4

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

Project	Napa Pipe Redevelopment	By	Ray	Date	3/3/2009
Location	Napa, California	Checked		Date	
Subshed name	Ex Watershed - Outfall 4	Check one:	☑ Present	☐ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

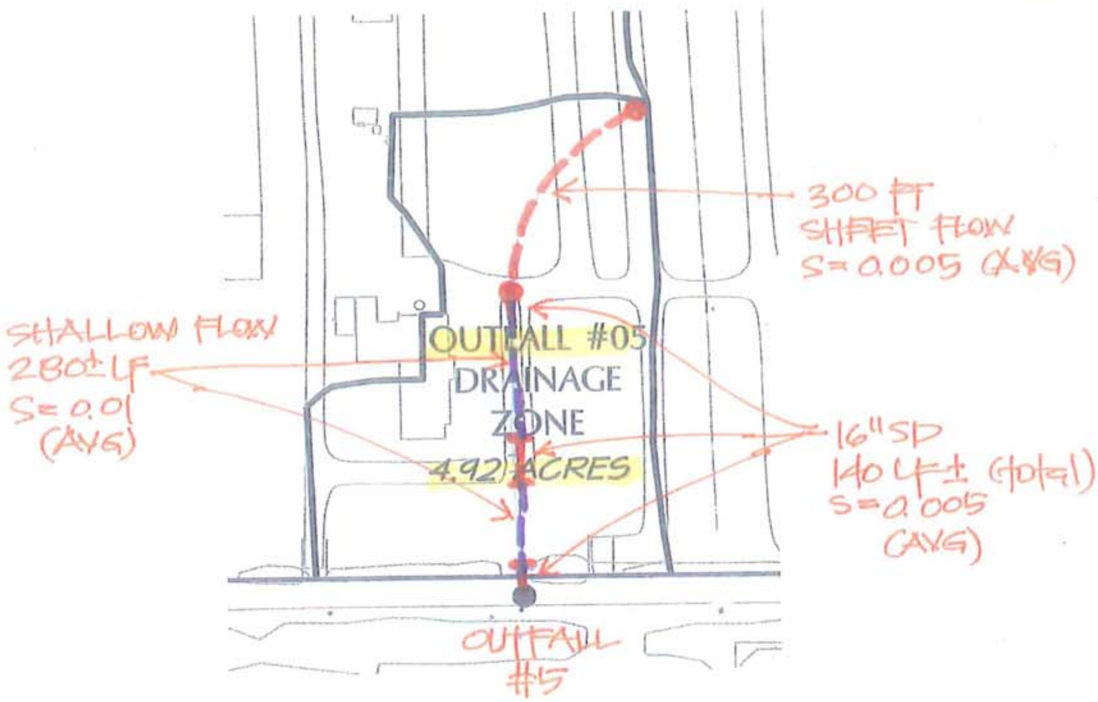
Segment ID		1				
1. Surface description (table 3-1)		Paved Area				
2. Manning's roughness coefficient, n (table3-1)		0.011				
3. Flow length, L (total L, 300 ft)	ft	300				
4. Two-year 24-hour rainfall, P_2	in	3				
5. Land slope, s	ft/ft	0.005				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\; s^{0.4}}$ Compute T_t	hr	0.0875	+		=	0.0875

SHALLOW CONCENTRATED FLOW

Segment ID		2				
7. Surface description (paved or unpaved)		Dense Grass				
8. Flow length, L	ft	770				
9. Watercourse slope, s	ft/ft	0.01				
10. Average velocity, V (figure 3-1)	ft/sec	1.6135				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.1326	+		=	0.1326

CHANNEL FLOW

Segment ID		2				
12. Cross sectional flow area, a	ft^2	1.3963				
13. Wetted perimeter, p_w	ft	4.1888				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft	0.3333				
15. Channel slope, s	ft/ft	0.005				
16. Manning's roughness coefficient, n		0.013				
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft/sec	3.8963				
18. Flow length, L	ft	350				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.0250	+		=	0.0250
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19)	hr					0.2450



EXISTING OUTFALL #5

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Ex Watershed - Outfall 5	Check one: ☑ Present ☐ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

Segment ID	1			
1. Surface description (table 3-1)	Bare Soil			
2. Manning's roughness coefficient, n (table3-1)	0.011			
3. Flow length, L (total L, 300 ft) . . . ft	300			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.005			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t . . hr	0.0875	+		= 0.0875

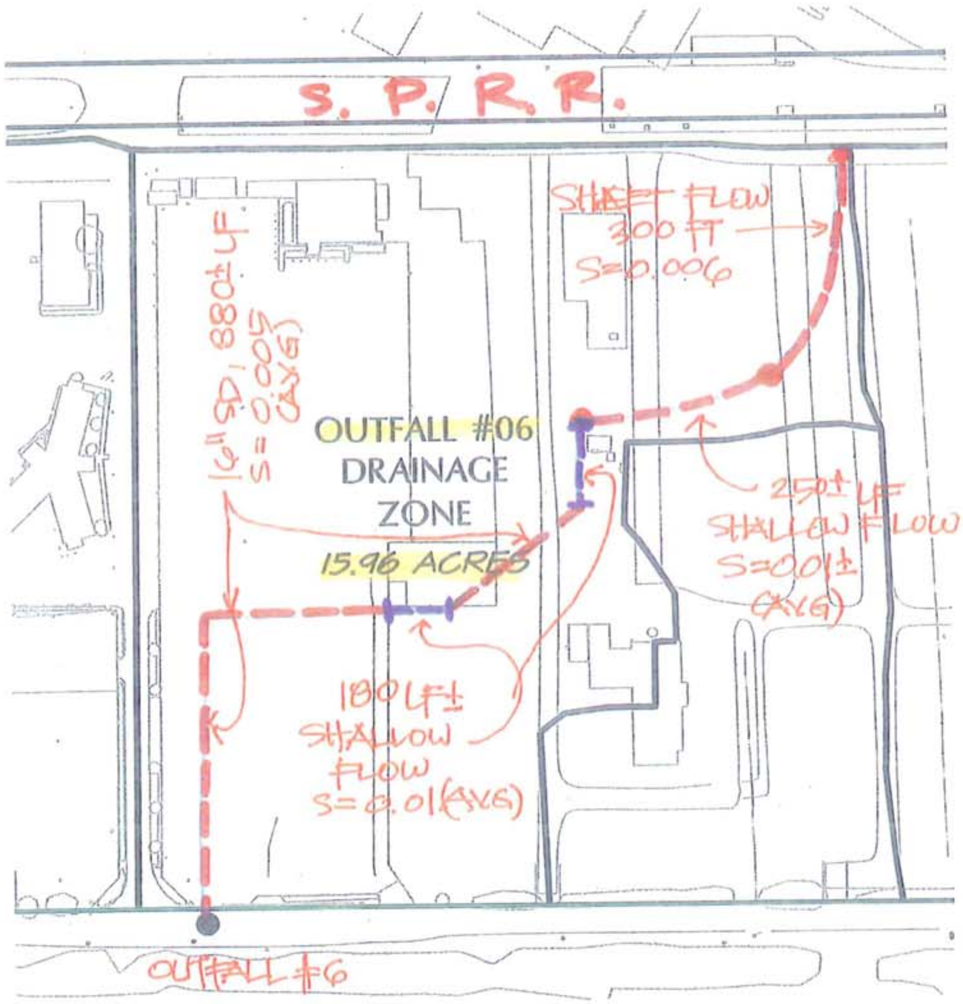
SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Dense Grass			
8. Flow length, L . . . ft	280			
9. Watercourse slope, s . . . ft/ft	0.01			
10. Average velocity, V (figure 3-1) . . . ft/sec	1.6135			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0482	+		= 0.0482

CHANNEL FLOW

Segment ID	3			
12. Cross sectional flow area, a . . . ft^2	1.3963			
13. Wetted perimeter, p_w . . . ft	4.1888			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3333			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec	3.8963			
18. Flow length, L . . . ft	140			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0100	+		= 0.0100
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.1456

USE 10 MIN = 0.1667



EXISTING OUTFALL #6

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

Project	Napa Pipe Redevelopment	By	Ray	Date	3/3/2009
Location	Napa, California	Checked		Date	
Subshed name	Ex Watershed - Outfall 6	Check one:	☑ Present	☐ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

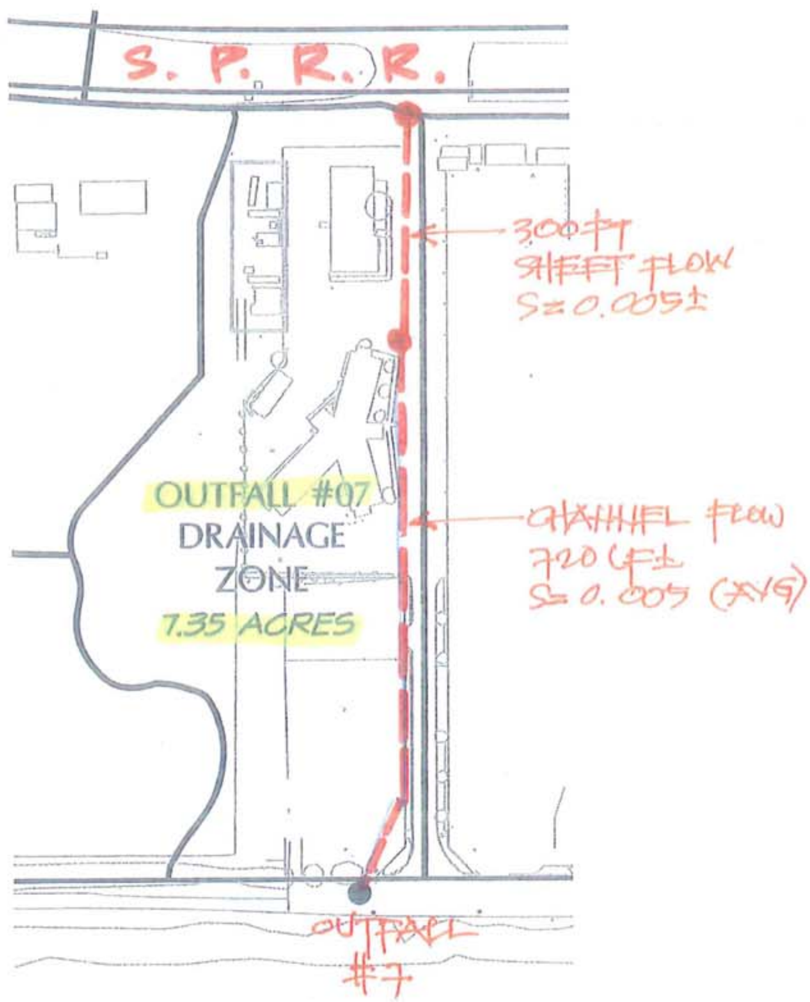
Segment ID	1			
1. Surface description (table 3-1)	Bare Soil			
2. Manning's roughness coefficient, n (table3-1)	0.011			
3. Flow length, L (total L, 300 ft) . . . ft	300			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.006			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\; s^{0.4}}$ Compute T_t . . hr	0.0813	+	=	0.0813

SHALLOW CONCENTRATED FLOW

Segment ID	2	3		
7. Surface description (paved or unpaved)	Bare Soil	Dense Grass		
8. Flow length, L . . . ft	250	180		
9. Watercourse slope, s . . . ft/ft	0.01	0.01		
10. Average velocity, V (figure 3-1) . . . ft/sec	1.6135	1.6135		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0430	+ 0.0310	=	0.0740

CHANNEL FLOW

Segment ID	4			
12. Cross sectional flow area, a . . . ft^2	1.3963			
13. Wetted perimeter, p_w . . . ft	4.1888			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3333			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V . ft/sec	3.8963			
18. Flow length, L . . . ft	880			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0627	+	=	0.0627
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.2181



EXISTING OUTFALL #7

Worksheet: Time of Concentration (Tc) or travel time (Tt)

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Ex Watershed - Outfall 7	Check one: ☑ Present ☐ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

Segment ID	1		
1. Surface description (table 3-1)	Paved Area		
2. Manning's roughness coefficient, n (table3-1)	0.011		
3. Flow length, L (total L, 300 ft) . . . ft	300		
4. Two-year 24-hour rainfall, P_2 . . . in	3		
5. Land slope, s . . . ft/ft	0.005		
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t . . . hr	0.0875	+	= 0.0875

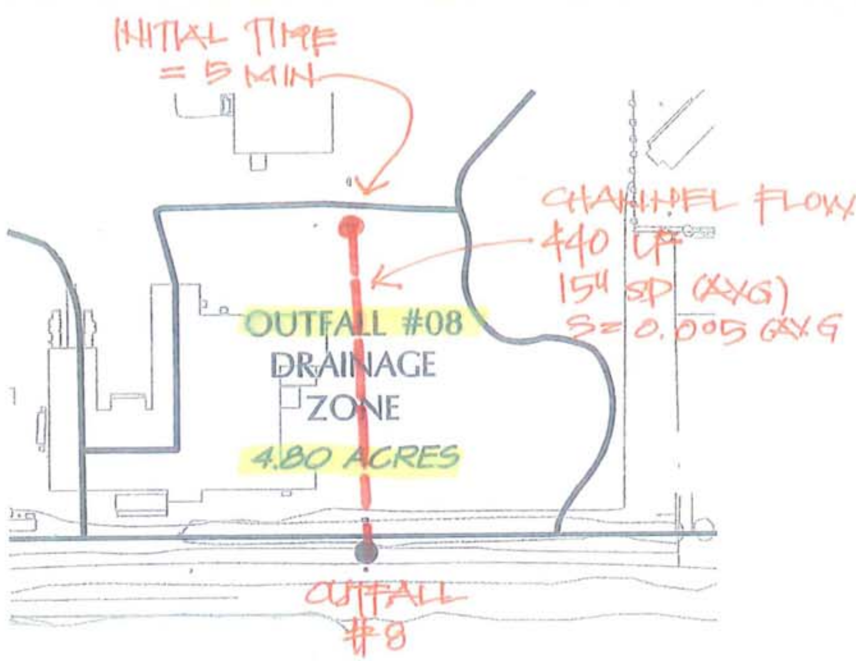
SHALLOW CONCENTRATED FLOW

Segment ID			
7. Surface description (paved or unpaved)			
8. Flow length, L . . . ft			
9. Watercourse slope, s . . . ft/ft			
10. Average velocity, V (figure 3-1) . . . ft/sec			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t . . . hr		+	=

CHANNEL FLOW

Segment ID	2		
12. Cross sectional flow area, a . . . ft²	1.2272		
13. Wetted perimeter, p_w . . . ft	3.927		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125		
15. Channel slope, s . . . ft/ft	0.005		
16. Manning's roughness coefficient, n	0.013		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V . ft/sec	3.7322		
18. Flow length, L . . . ft	720		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t . . . hr	0.0536	+	= 0.0536
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr			0.1410

USE 10 Min = 0.1667



EXISTING OUTFALL #8

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

Project	Napa Pipe Redevelopment	By	Ray	Date	3/3/2009
Location	Napa, California	Checked		Date	
Subshed name	Ex Watershed - Outfall 8	Check one:	☑ Present	☐ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes (Roof to Inlet)		
2. Manning's roughness coefficient, n (table3-1)	0.15			
3. Flow length, L (total L, 300 ft) . . . ft	40			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.0186			
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t . . hr	0.0834	+	=	0.0834

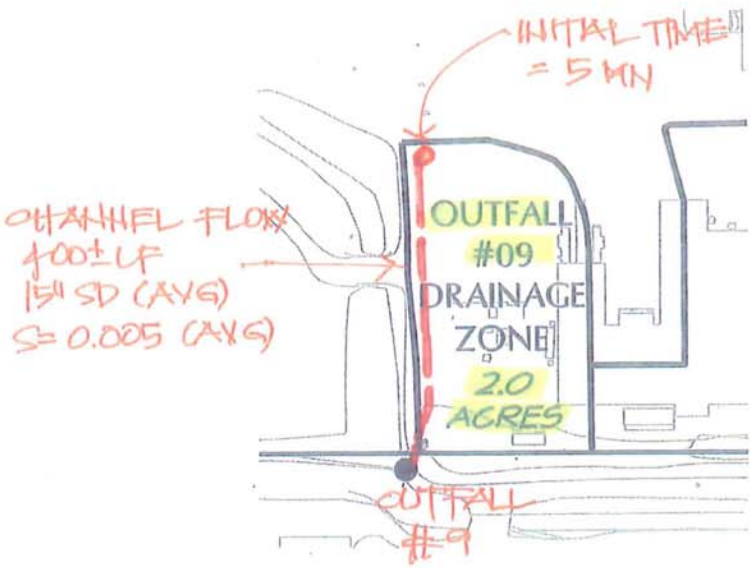
SHALLOW CONCENTRATED FLOW

Segment ID				
7. Surface description (paved or unpaved)				
8. Flow length, L . . . ft				
9. Watercourse slope, s . . . ft/ft				
10. Average velocity, V (figure 3-1) . . . ft/sec				
11. $T_t = \frac{L}{3600 V}$ Compute T_t . . hr		+	=	

CHANNEL FLOW

Segment ID	2			
12. Cross sectional flow area, a . . . ft^2	1.2272			
13. Wetted perimeter, p_w . . . ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n . . .	0.013			
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec	3.7322			
18. Flow length, L . . . ft	440			
11. $T_t = \frac{L}{3600 V}$ Compute T_t . . hr	0.0327	+	=	0.0327
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.1162

USE 10 MIN = 0.1667



EXISTING OUTFALL #9

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Ex Watershed - Outfall 9	Check one: ☑ Present ☐ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes (Roof to Inlet)		
2. Manning's roughness coefficient, n (table3-1)	0.15			
3. Flow length, L (total L, 300 ft) . . . ft	40			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.0186			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t . . hr	0.0834	+	=	0.0834

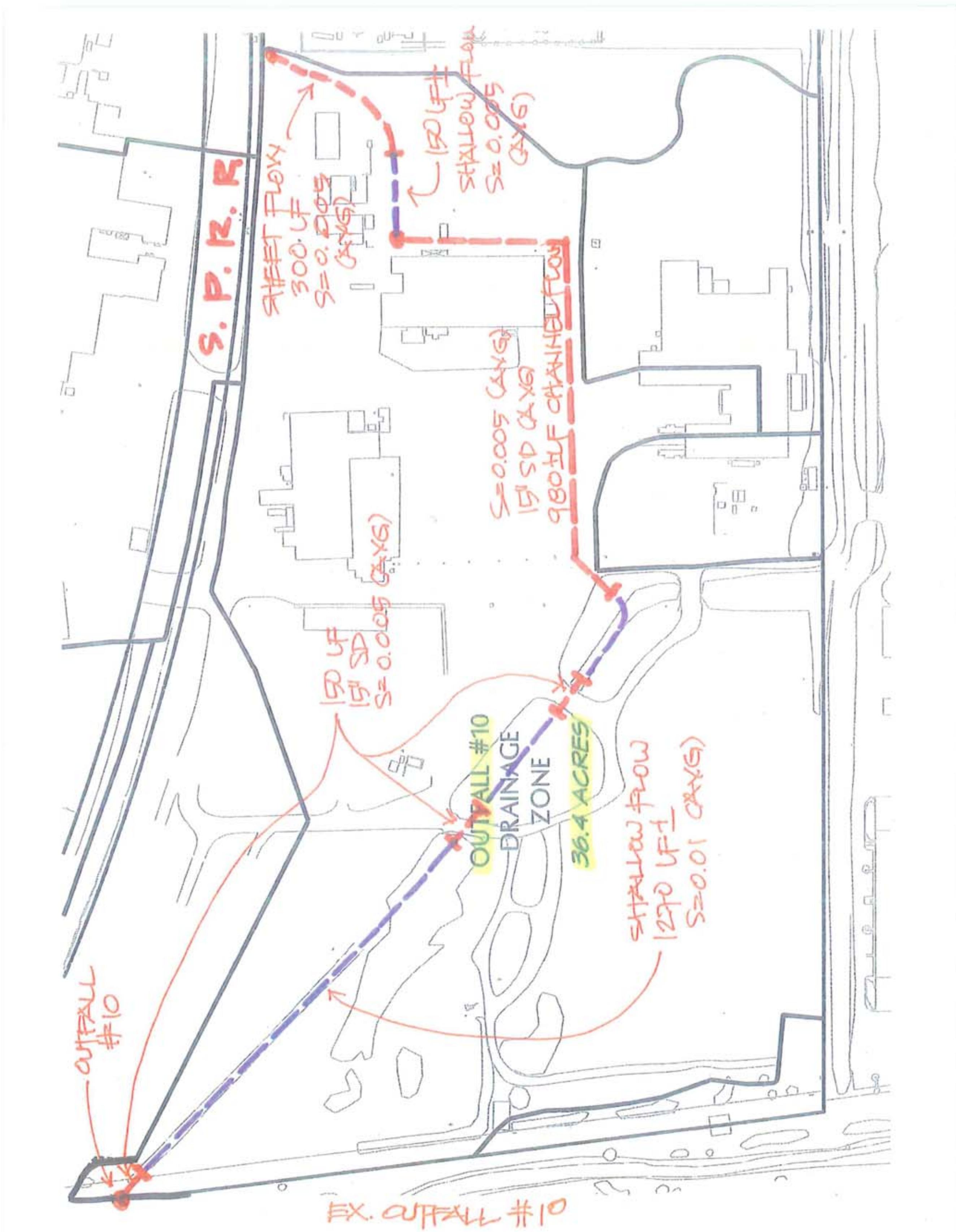
SHALLOW CONCENTRATED FLOW

Segment ID				
7. Surface description (paved or unpaved)				
8. Flow length, L . . . ft				
9. Watercourse slope, s . . . ft/ft				
10. Average velocity, V (figure 3-1) . . . ft/sec				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr		+	=	

CHANNEL FLOW

Segment ID	2			
12. Cross sectional flow area, a . . . ft^2	1.2272			
13. Wetted perimeter, p_w . . . ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V . ft/sec	3.7322			
18. Flow length, L . . . ft	400			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0298	+	=	0.0298
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.1132

USE 10 Min = 0.1667


S. P. R. R.
SHEET FLOW
300 LF
S=0.005
(AVG)
150 LF±
SHALLOW FLOW
S=0.005
(AVG)
S=0.005 (AVG)
15" SD (AVG)
980±LF CHANNEL FLOW
150 LF
15" SD
S=0.005 (AVG)
OUTFALL #10
DRAINAGE
ZONE
36.4 ACRES
SHALLOW FLOW
1270 LF±
S=0.01 (AVG)
OUTFALL
#10
EX. OUTFALL #10

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

Project	Napa Pipe Redevelopment	By	Ray	Date	3/3/2009
Location	Napa, California	Checked		Date	
Subshed name	Ex Watershed - Outfall 10	Check one:	☑ Present	☐ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

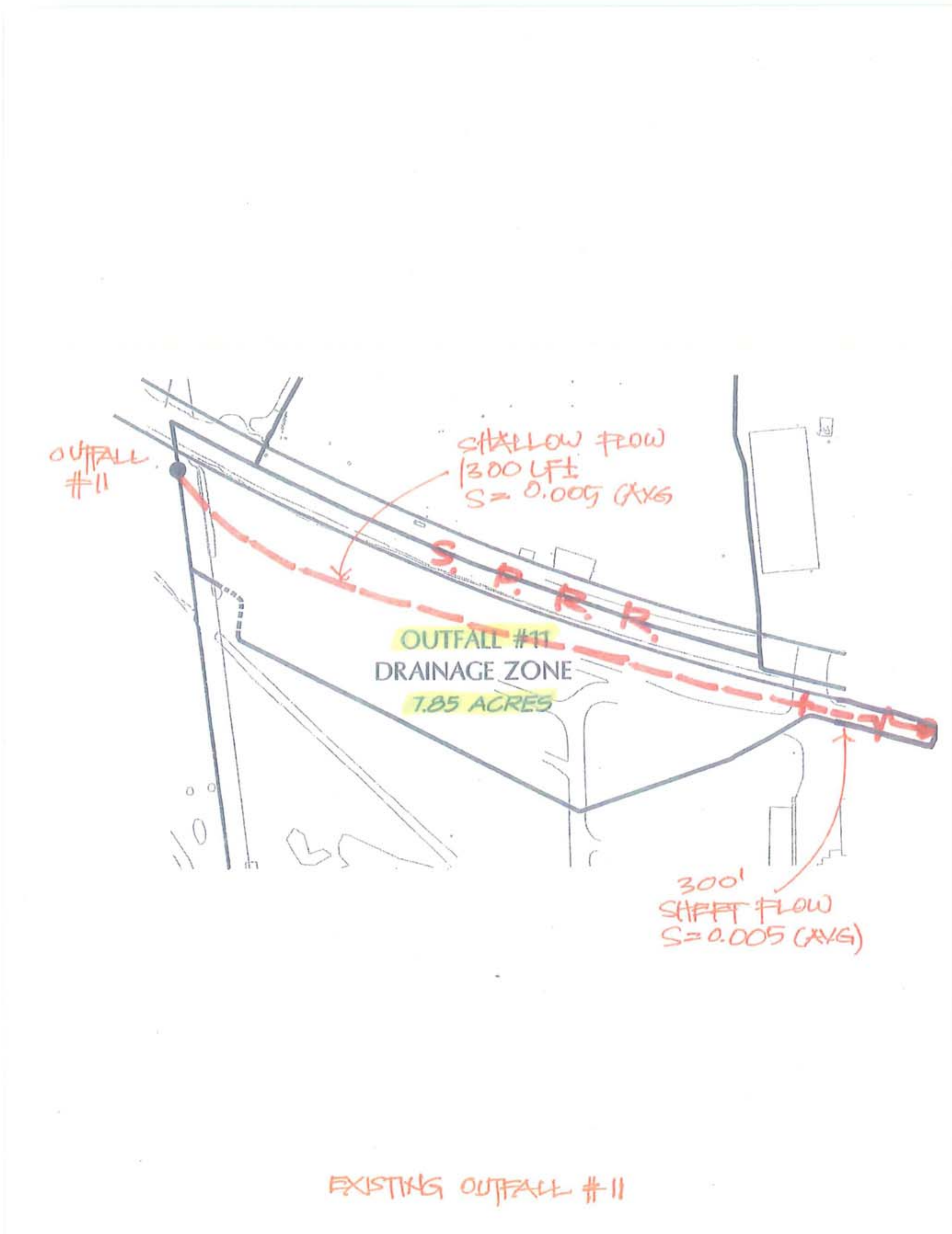
Segment ID		1			
1. Surface description (table 3-1)		Paved Area			
2. Manning's roughness coefficient, n (table3-1)		0.011			
3. Flow length, L (total L, 300 ft)	ft	300			
4. Two-year 24-hour rainfall, P_2	in	3			
5. Land slope, s	ft/ft	0.005			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\, s^{0.4}}$ Compute T_t	hr	0.0875	+	=	0.0875

SHALLOW CONCENTRATED FLOW

Segment ID		2	3		
7. Surface description (paved or unpaved)		Paved Area	Dense Grass		
8. Flow length, L	ft	150	1,270		
9. Watercourse slope, s	ft/ft	0.005	0.01		
10. Average velocity, V (figure 3-1)	ft/sec	1.1409	1.6135		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.0365	+ 0.2186	=	0.2552

CHANNEL FLOW

Segment ID		4	5		
12. Cross sectional flow area, a	ft^2	1.2272	1.2272		
13. Wetted perimeter, p_w	ft	3.927	3.927		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft	0.3125	0.3125		
15. Channel slope, s	ft/ft	0.005	0.005		
16. Manning's roughness coefficient, n		0.013	0.013		
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V	ft/sec	3.7322	3.7322		
18. Flow length, L	ft	980	150		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	0.0729	+ 0.0112	=	0.0841
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19)	hr				0.4267


OUTFALL
#11
SHALLOW FLOW
1300 LF±
S= 0.005 (AVG
S. P. R. R.
OUTFALL #11
DRAINAGE ZONE
7.85 ACRES
300'
SHEET FLOW
S=0.005 (AVG)
EXISTING OUTFALL #11

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked:	Date:	
Subshed name: Ex Watershed - Outfall 11	Check one: ☑ Present ☐ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

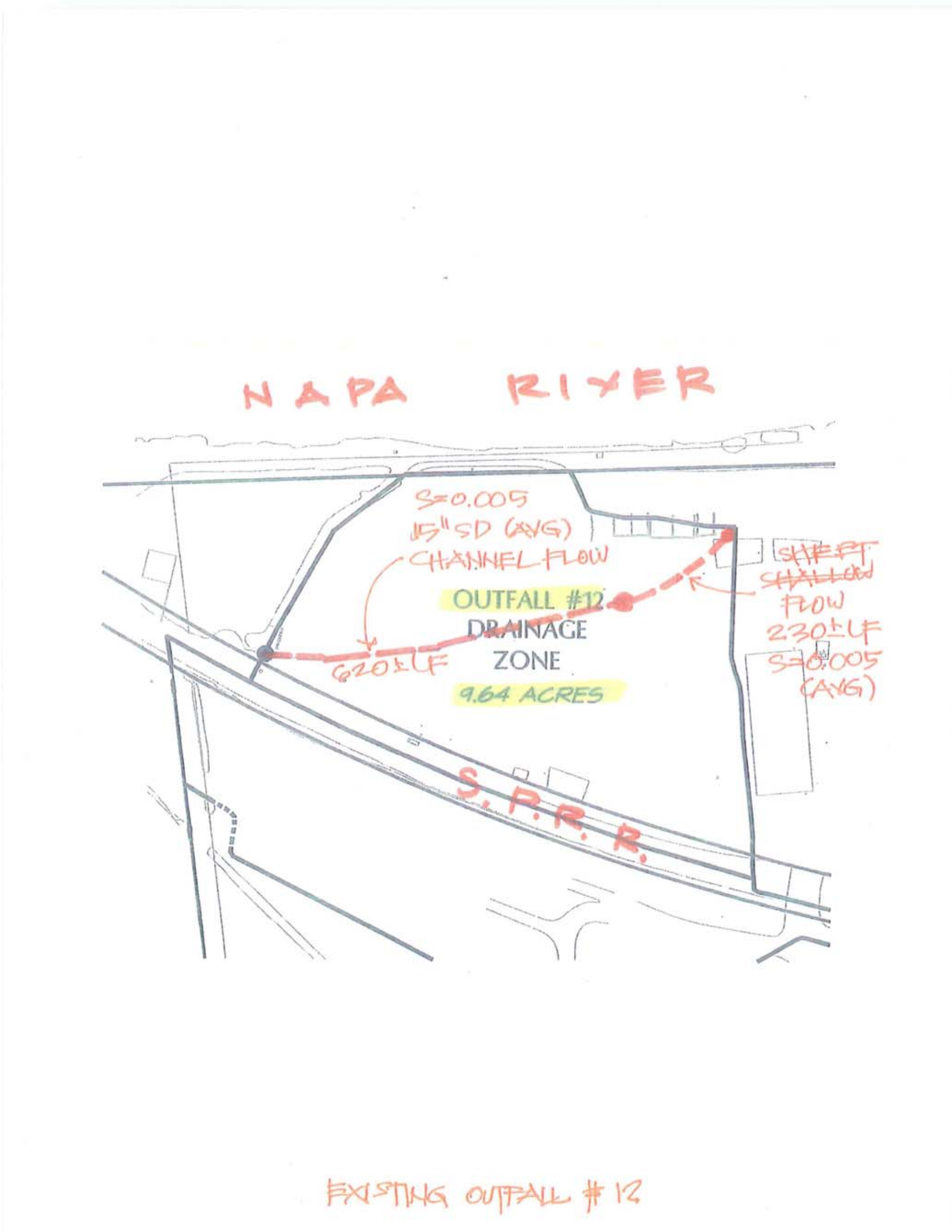
Segment ID	1			
1. Surface description (table 3-1)	Paved Area			
2. Manning's roughness coefficient, n (table3-1)	0.011			
3. Flow length, L (total L, 300 ft) . . . ft	300			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.005			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\; s^{0.4}}$ Compute T_t . . . hr	0.0875	+	=	0.0875

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Bare Soil/Paved			
8. Flow length, L . . . ft	1300			
9. Watercourse slope, s . . . ft/ft	0.005			
10. Average velocity, V (figure 3-1) . . . ft/sec	1.1409			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr	0.3165	+	=	0.3165

CHANNEL FLOW

Segment ID				
12. Cross sectional flow area, a . . . ft²				
13. Wetted perimeter, p_w . . . ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft				
15. Channel slope, s . . . ft/ft				
16. Manning's roughness coefficient, n . . .				
17. $V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec				
18. Flow length, L . . . ft				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr		+	=	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.4040


NAPA RIVER
S=0.005
15"SD (AVG)
CHANNEL FLOW
OUTFALL #12
DRAINAGE
ZONE
9.64 ACRES
620±LF
SHALLOW
FLOW
230±LF
S=0.005
(AVG)
S.P.R.R.
EXISTING OUTFALL #12

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Ex Watershed - Outfall 12	Check one: ☑ Present ☐ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

	Segment 1	Segment 2		Total
Segment ID	1			
1. Surface description (table 3-1)	Bare Soil			
2. Manning's roughness coefficient, n (table3-1)	0.011			
3. Flow length, L (total L, 300 ft) . . . ft	300			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.005			
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t . . hr	0.0875	+	=	0.0875

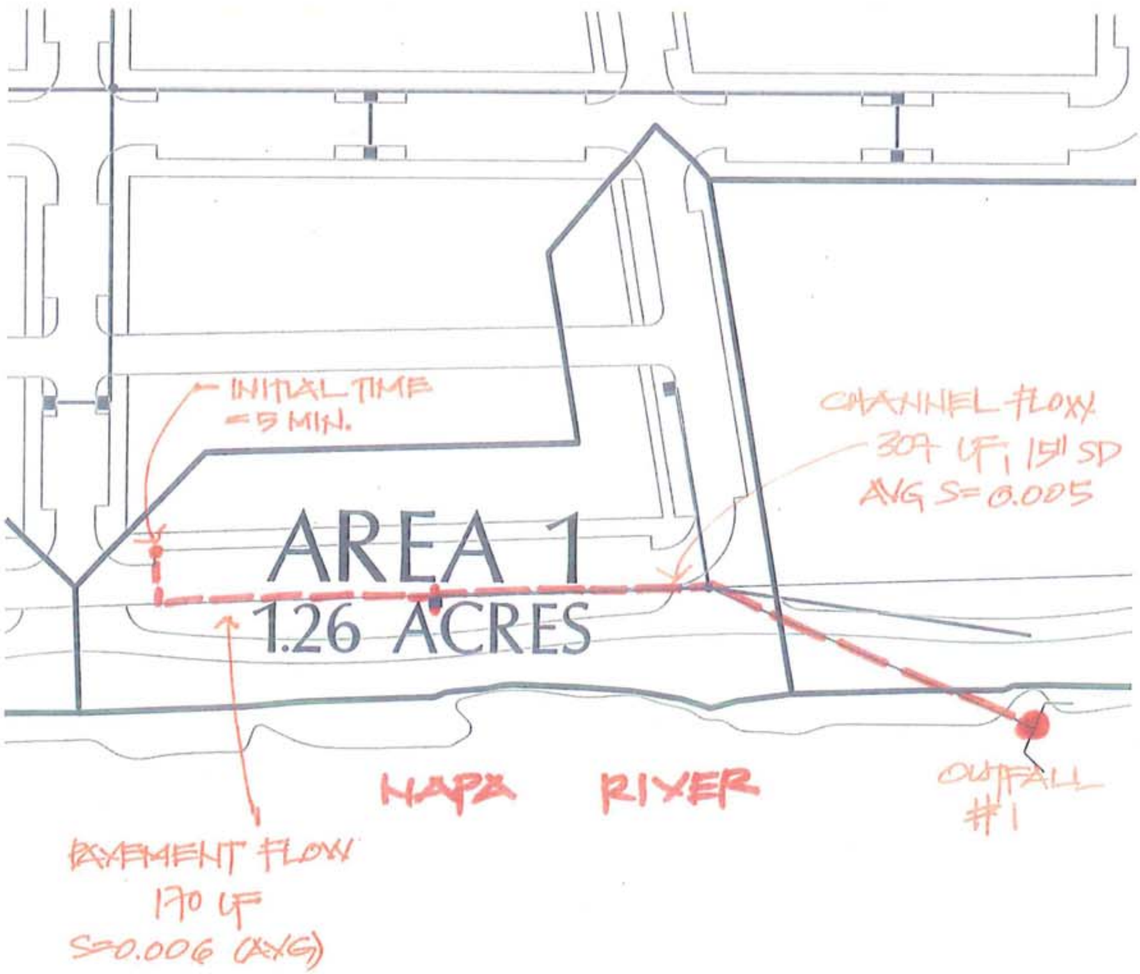
SHALLOW CONCENTRATED FLOW

	Segment 1	Segment 2		Total
Segment ID				
7. Surface description (paved or unpaved)				
8. Flow length, L . . . ft				
9. Watercourse slope, s . . . ft/ft				
10. Average velocity, V (figure 3-1) . . . ft/sec				
11. $T_t = \frac{L}{3600 V}$ Compute T_t . . hr		+	=	

CHANNEL FLOW

	Segment 1	Segment 2		Total
Segment ID	2			
12. Cross sectional flow area, a . . . ft^2	1.2272			
13. Wetted perimeter, p_w . . . ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec	3.7322			
18. Flow length, L . . . ft	620			
11. $T_t = \frac{L}{3600 V}$ Compute T_t . . hr	0.0461	+	=	0.0461
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.1336

USE 10 MIN = 0.1667



PROPOSED OUTFALL #1

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 1	Check one:	☐ Present	☑ Developed
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one:	☑ Tc	☐ Tt through subarea

SHEET FLOW (applicable to Tc only)

	Segment 1	Segment 2		Total
Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes		
2. Manning's roughness coefficient, n (table3-1)	0.15	(Roof		
3. Flow length, L (total L, 300 ft) . . . ft	40	to		
4. Two-year 24-hour rainfall, P_2 . . . in	3	Gutter)		
5. Land slope, s . . . ft/ft	0.0186			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\; s^{0.4}}$ Compute T_t . . hr	0.0834	+	=	0.0834

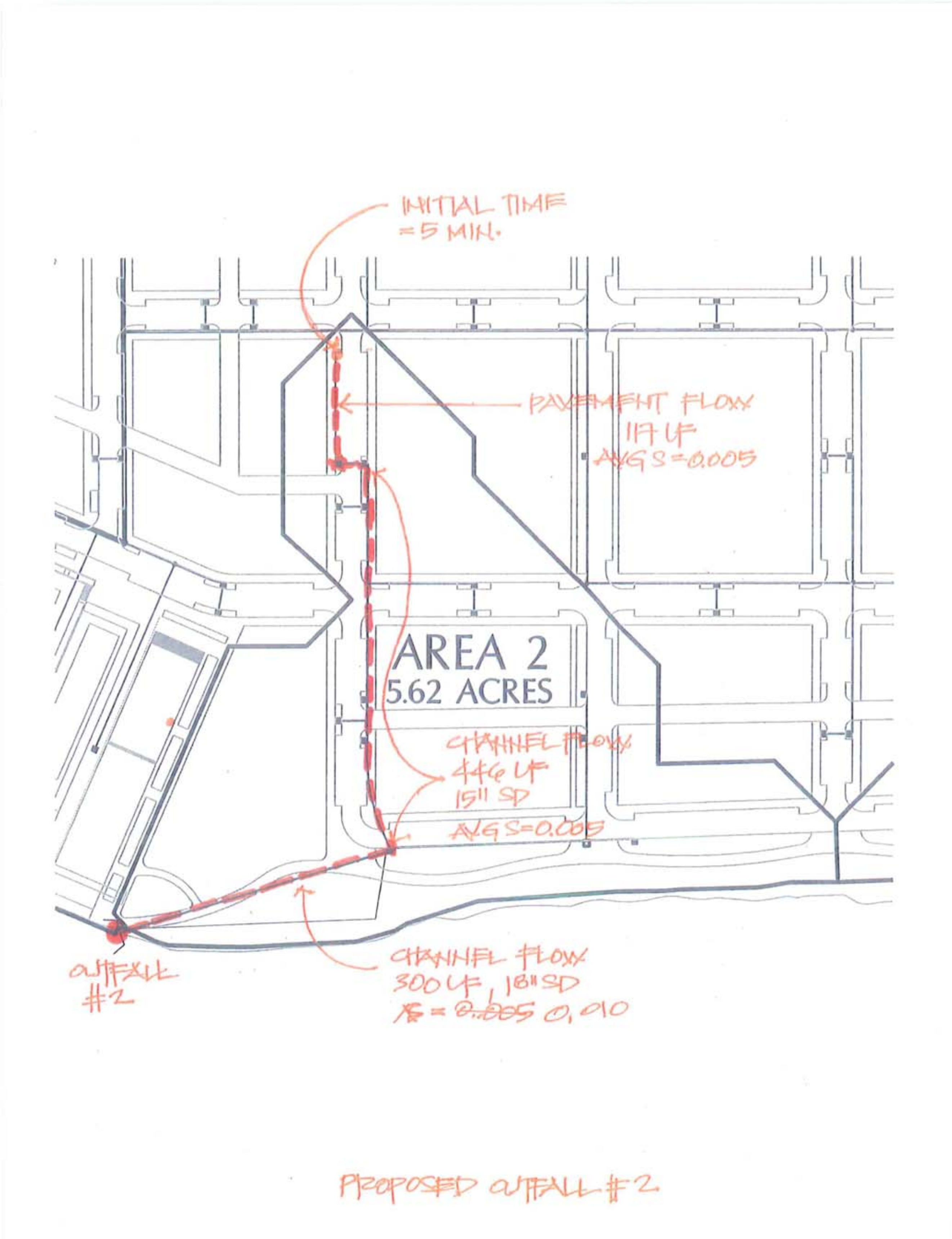
SHALLOW CONCENTRATED FLOW

	Segment 1	Segment 2		Total
Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L . . . ft	170			
9. Watercourse slope, s . . . ft/ft	0.006			
10. Average velocity, V (figure 3-1) . . . ft/sec	1.2498			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0378	+	=	0.0378

CHANNEL FLOW

	Segment 1	Segment 2		Total
Segment ID	2			
12. Cross sectional flow area, a . . . ft^2	1.2272			
13. Wetted perimeter, p_w . . . ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V . ft/sec	3.7322			
18. Flow length, L . . . ft	307			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0228	+	=	0.0228
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.1441

USE 10 Min = 0.1667


INITIAL TIME
=5 MIN.
PAVEMENT FLOW
117 LF
AVG S=0.005
AREA 2
5.62 ACRES
CHANNEL FLOW
446 LF
15" SD
AVG S=0.005
OUTFALL
#2
CHANNEL FLOW
300 LF, 18" SD
S = 0.010
PROPOSED OUTFALL #2

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

Project	Napa Pipe Redevelopment	By	Ray	Date	3/3/2009
Location	Napa, California	Checked		Date	
Subshed name	Proposed Watershed - Outfall 2	Check one:	☐ Present	☑ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes (Roof to Gutter)		
2. Manning's roughness coefficient, n (table3-1)	0.15			
3. Flow length, L (total L, 300 ft) . . . ft	40			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.0186			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\; s^{0.4}}$ Compute T_t . . . hr	0.0834	+	=	0.0834

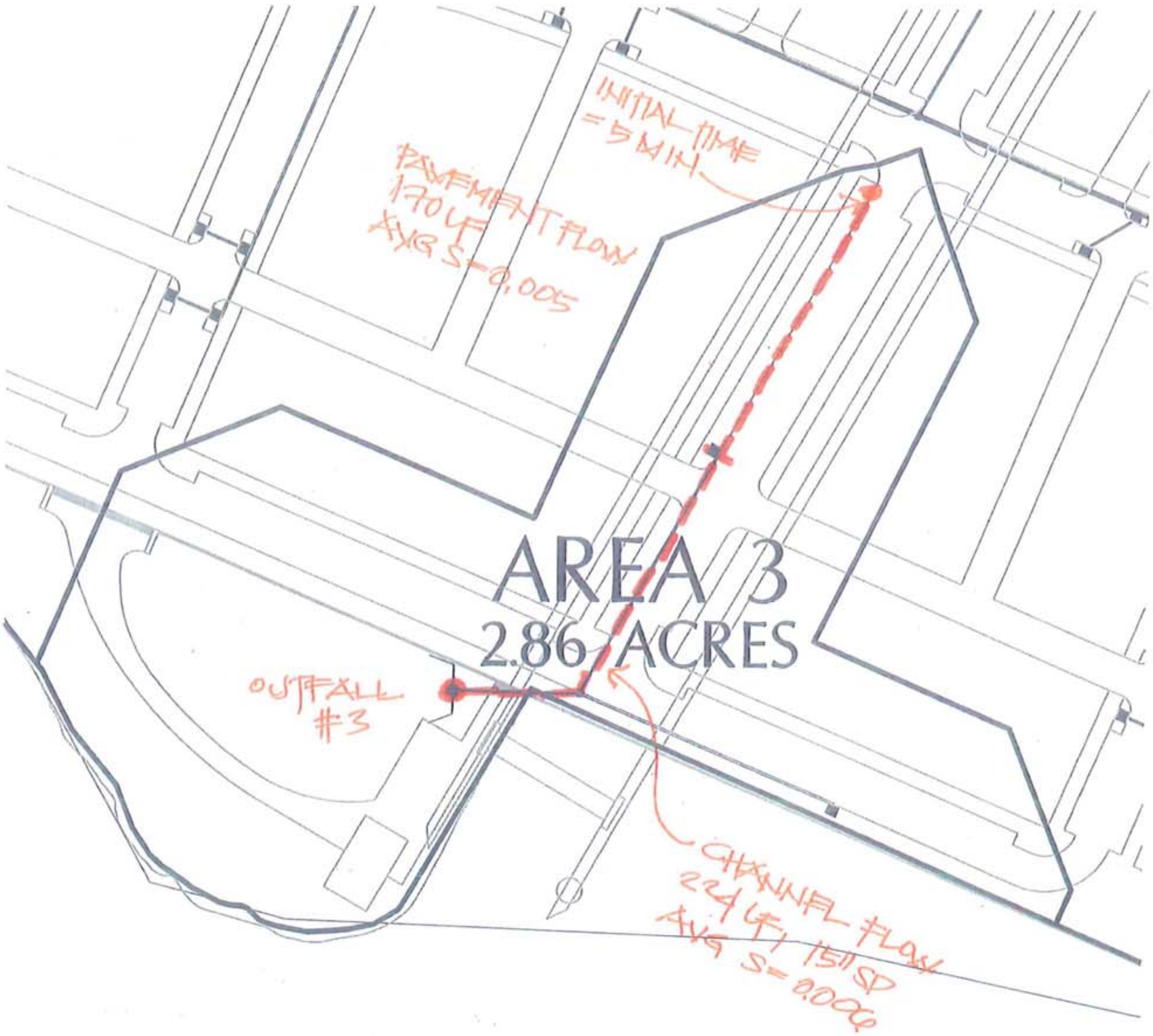
SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L . . . ft	117			
9. Watercourse slope, s . . . ft/ft	0.005			
10. Average velocity, V (figure 3-1) . . . ft/sec	1.1409			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr	0.0285	+	=	0.0285

CHANNEL FLOW

Segment ID	3	4	
12. Cross sectional flow area, a . . . ft²	1.2272	1.7671	
13. Wetted perimeter, p_w . . . ft	3.927	4.7124	
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125	0.3750	
15. Channel slope, s . . . ft/ft	0.005	0.01	
16. Manning's roughness coefficient, n	0.013	0.013	
17. $V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec	3.7322	5.9601	
18. Flow length, L . . . ft	446	300	
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0332	+ 0.0140	= 0.0472
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr			0.1591

USE 10 Min = 0.1667



PROPOSED OUTFALL #3

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 3	Check one: ☐ Present	☑ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes		
2. Manning's roughness coefficient, n (table3-1)	0.15	(Roof		
3. Flow length, L (total L, 300 ft) ... ft	40	to		
4. Two-year 24-hour rainfall, P_2 ... in	3	Gutter)		
5. Land slope, s ... ft/ft	0.0186			
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t ... hr	0.0834	+	=	0.0834

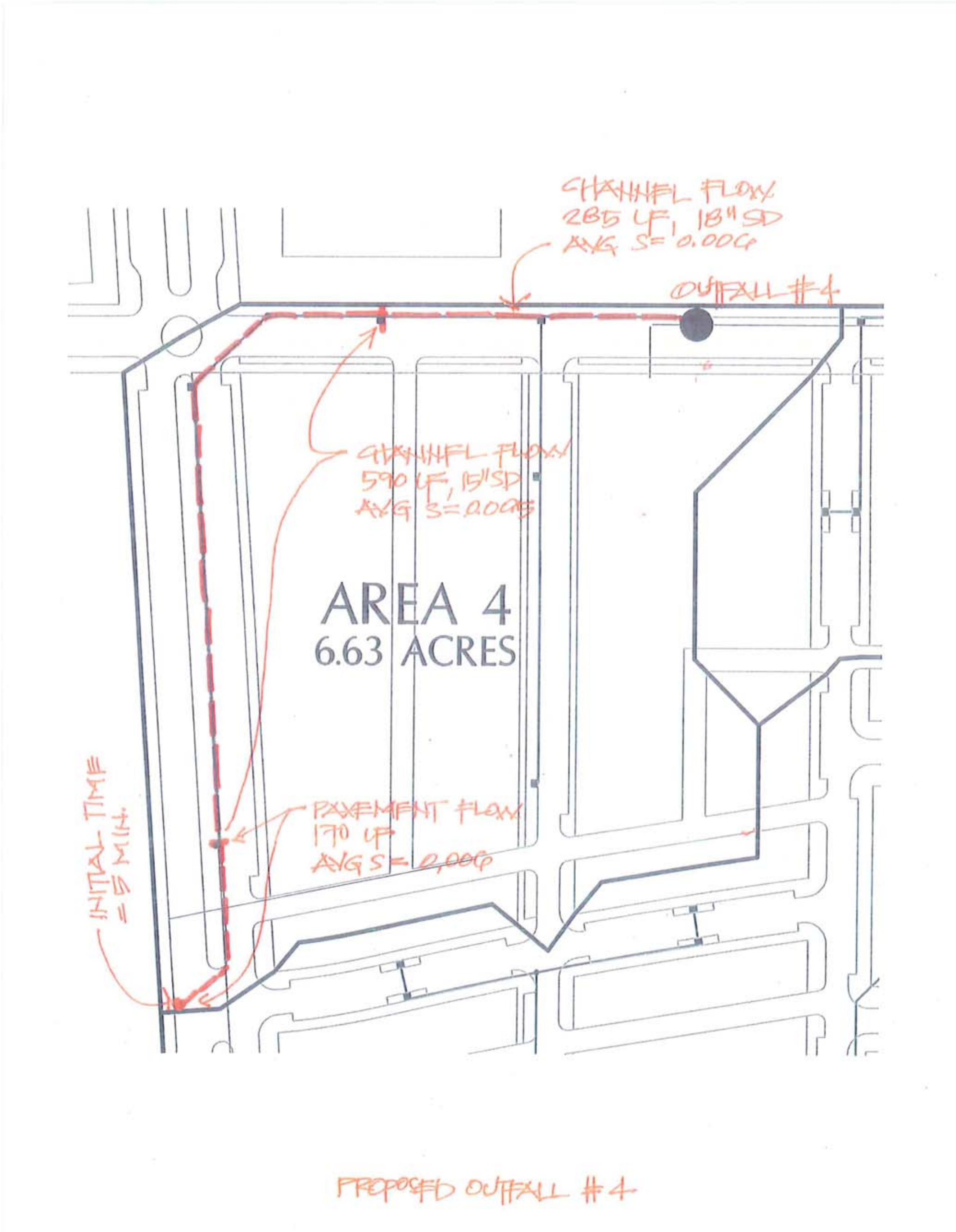
SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L ... ft	170			
9. Watercourse slope, s ... ft/ft	0.005			
10. Average velocity, V (figure 3-1) ... ft/sec	1.1409			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t ... hr	0.0414	+	=	0.0414

CHANNEL FLOW

Segment ID	3			
12. Cross sectional flow area, a ... ft^2	1.2272			
13. Wetted perimeter, p_w ... ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ... ft	0.3125			
15. Channel slope, s ... ft/ft	0.006			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V . ft/sec	4.0884			
18. Flow length, L ... ft	224			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t ... hr	0.0152	+	=	0.0152
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) ... hr				0.1400

USE 10 Min = 0.1667


CHANNEL FLOW
285 LF, 18" SD
AVG S= 0.006
OUTFALL #4
CHANNEL FLOW
590 LF, 15" SD
AVG S=0.0065
AREA 4
6.63 ACRES
PAVEMENT FLOW
170 LF
AVG S = 0.006
INITIAL TIME
= 5 MIN.
PROPOSED OUTFALL #4

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 4	Check one: ☐ Present ☑ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

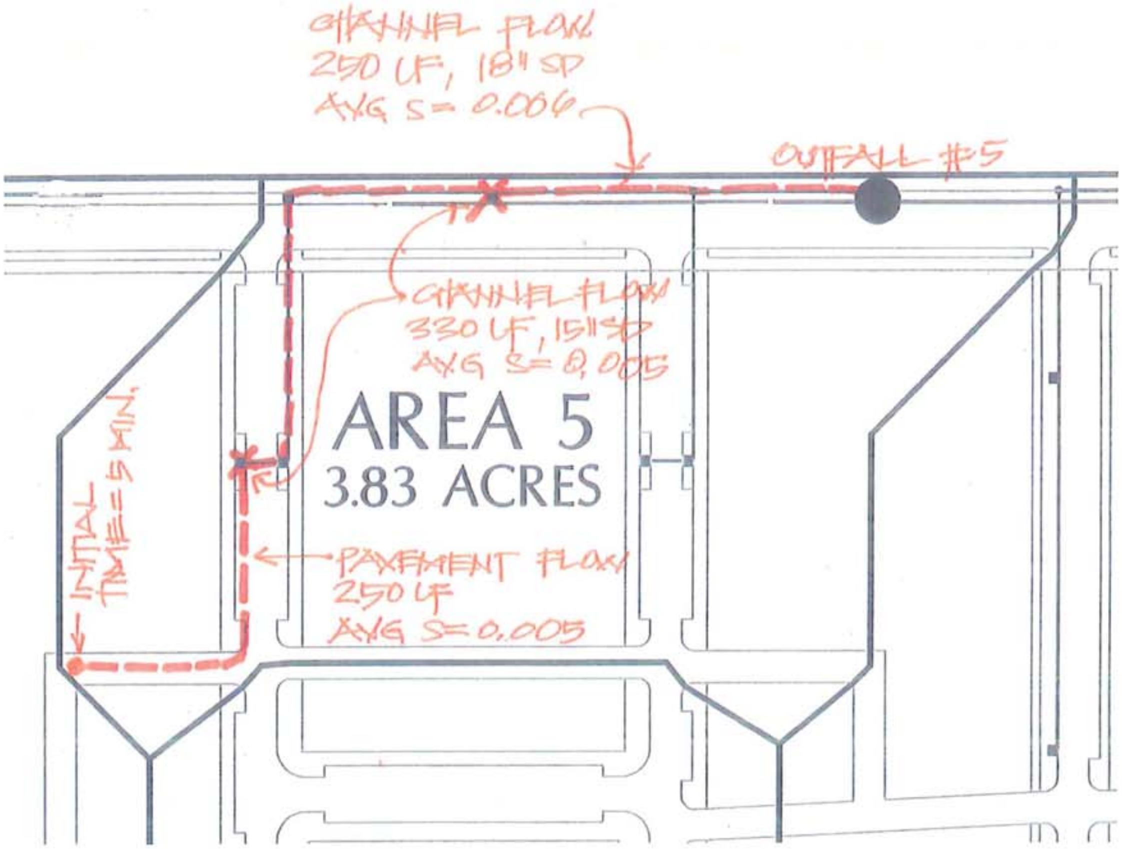
Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes (Roof to Gutter)		
2. Manning's roughness coefficient, n (table3-1)	0.15			
3. Flow length, L (total L, 300 ft) ... ft	40			
4. Two-year 24-hour rainfall, P_2 ... in	3			
5. Land slope, s ... ft/ft	0.0186			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t ... hr	0.0834	+	=	0.0834

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L ... ft	170			
9. Watercourse slope, s ... ft/ft	0.006			
10. Average velocity, V (figure 3-1) ... ft/sec	1.2498			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t ... hr	0.0378	+	=	0.0378

CHANNEL FLOW

Segment ID	3	4		
12. Cross sectional flow area, a ... ft²	1.2272	1.7671		
13. Wetted perimeter, p_w ... ft	3.927	4.7124		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ... ft	0.3125	0.3750		
15. Channel slope, s ... ft/ft	0.005	0.005		
16. Manning's roughness coefficient, n	0.013	0.013		
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V ... ft/sec	3.7322	4.2144		
18. Flow length, L ... ft	590	285		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t ... hr	0.0439	+ 0.0188	=	0.0627
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) ... hr				0.1839



PROPOSED OUTFALL #5

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 5	Check one: ☐ Present ☑ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

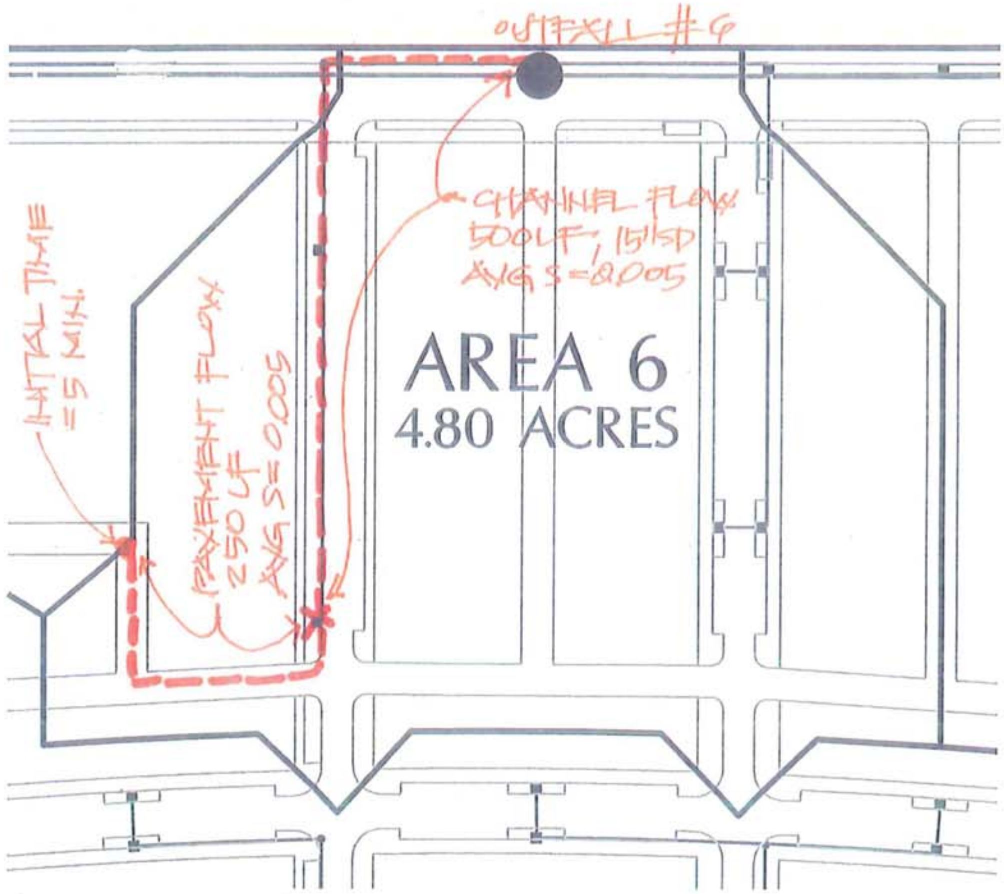
Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes		
2. Manning's roughness coefficient, n (table3-1) . .	0.15	(Roof		
3. Flow length, L (total L, 300 ft) . . . . ft	40	to		
4. Two-year 24-hour rainfall, P_2 . . . . in	3	Pavement)		
5. Land slope, s . . . . ft/ft	0.0186			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\; s^{0.4}}$ Compute T_t . . hr	0.0834	+	=	0.0834

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L . . . . ft	250			
9. Watercourse slope, s . . . . ft/ft	0.005			
10. Average velocity, V (figure 3-1) . . . . ft/sec	1.1409			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0609	+	=	0.0609

CHANNEL FLOW

Segment ID	3	4		
12. Cross sectional flow area, a . . . . ft^2	1.2272	1.7671		
13. Wetted perimeter, p_w . . . . ft	3.927	4.7124		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125	0.3750		
15. Channel slope, s . . . . ft/ft	0.005	0.006		
16. Manning's roughness coefficient, n	0.013	0.013		
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V . ft/sec	3.7322	4.6167		
18. Flow length, L . . . . ft	330	250		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0246	+ 0.0150	=	0.0396
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . . hr				0.1839



PROPOSED OUTFALL #6

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 6	Check one: ☐ Present ☑ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

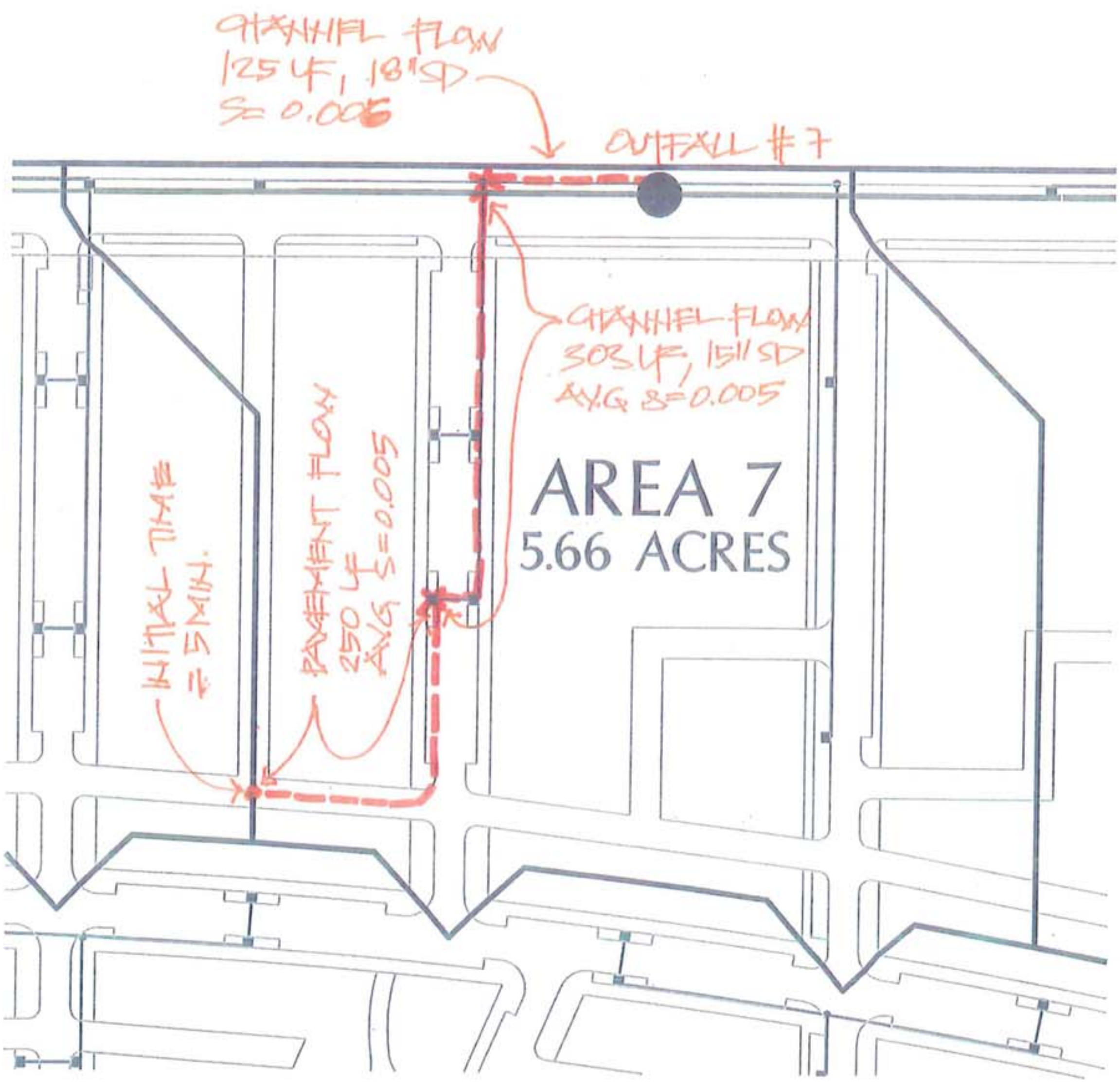
Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes (Roof to Pavement)		
2. Manning's roughness coefficient, n (table3-1)	0.15			
3. Flow length, L (total L, 300 ft) ... ft	40			
4. Two-year 24-hour rainfall, P_2 ... in	3			
5. Land slope, s ... ft/ft	0.0186			
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} \; s^{0.4}}$ Compute T_t ... hr	0.0834	+	=	0.0834

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L ... ft	250			
9. Watercourse slope, s ... ft/ft	0.005			
10. Average velocity, V (figure 3-1) ... ft/sec	1.1409			
11. $T_t = \frac{L}{3600 V}$ Compute T_t ... hr	0.0609	+	=	0.0609

CHANNEL FLOW

Segment ID	3			
12. Cross sectional flow area, a ... ft^2	1.2272			
13. Wetted perimeter, p_w ... ft	3.927			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ... ft	0.3125			
15. Channel slope, s ... ft/ft	0.005			
16. Manning's roughness coefficient, n	0.013			
17. $V = \frac{1.49 \, r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec	3.7322			
18. Flow length, L ... ft	500			
11. $T_t = \frac{L}{3600 V}$ Compute T_t ... hr	0.0372	+	=	0.0372
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) ... hr				0.1815



PROPOSED OUTFALL #7

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked:	Date:	
Subshed name: Proposed Watershed - Outfall 7	Check one: ☐ Present	☑ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

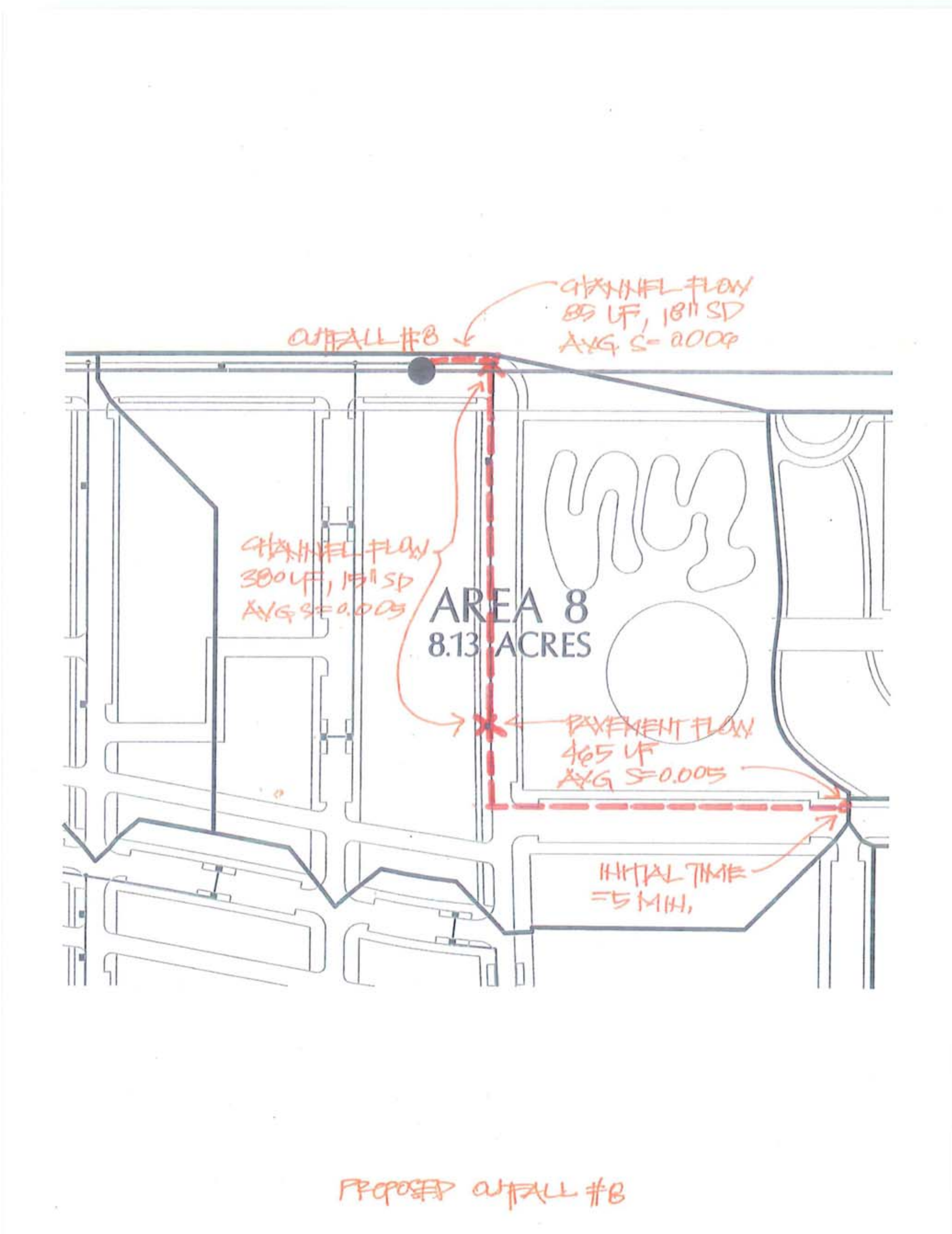
Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes (Roof to Pavement)		
2. Manning's roughness coefficient, n (table3-1)	0.15			
3. Flow length, L (total L, 300 ft) . . . ft	40			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.0186			
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t . . . hr	0.0834	+	=	0.0834

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L . . . ft	250			
9. Watercourse slope, s . . . ft/ft	0.005			
10. Average velocity, V (figure 3-1) . . . ft/sec	1.1409			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t . . . hr	0.0609	+	=	0.0609

CHANNEL FLOW

Segment ID	3	4	
12. Cross sectional flow area, a . . . ft²	1.2272	1.7671	
13. Wetted perimeter, p_w . . . ft	3.927	4.7124	
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125	0.3750	
15. Channel slope, s . . . ft/ft	0.005	0.006	
16. Manning's roughness coefficient, n	0.013	0.013	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V . ft/sec	3.7322	4.6167	
18. Flow length, L . . . ft	303	125	
11. $T_t = \frac{L}{3600\ V}$ Compute T_t . . . hr	0.0226	+ 0.0075	= 0.0301
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr			0.1744


CHANNEL FLOW
85 LF, 18" SD
AVG S=0.006
OUTFALL #8
CHANNEL FLOW
380 LF, 15" SD
AVG S=0.005
AREA 8
8.13 ACRES
PAVEMENT FLOW
465 LF
AVG S=0.005
INITIAL TIME
=5 MIN.
PROPOSED OUTFALL #8

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked:	Date:	
Subshed name: Proposed Watershed - Outfall 8	Check one:	☐ Present	☑ Developed
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one:	☑ Tc	☐ Tt through subarea

SHEET FLOW (applicable to Tc only)

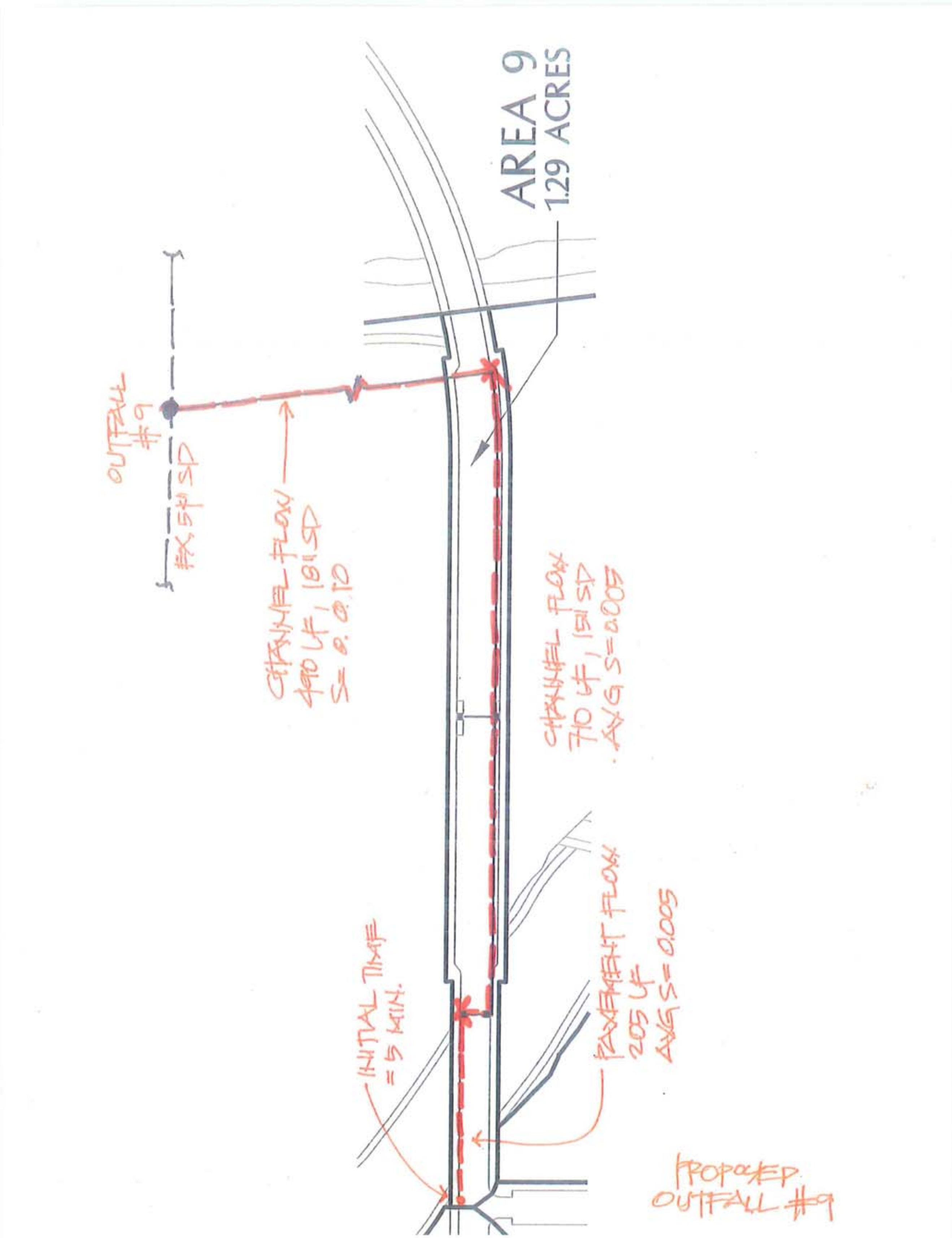
Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes (Roof to Gutter)		
2. Manning's roughness coefficient, n (table3-1)	0.15			
3. Flow length, L (total L, 300 ft) ... ft	40			
4. Two-year 24-hour rainfall, P_2 ... in	3			
5. Land slope, s ... ft/ft	0.0186			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t ... hr	0.0834	+	=	0.0834

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L ... ft	465			
9. Watercourse slope, s ... ft/ft	0.005			
10. Average velocity, V (figure 3-1) ... ft/sec	1.1409			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t ... hr	0.1132	+	=	0.1132

CHANNEL FLOW

Segment ID	3	4	
12. Cross sectional flow area, a ... ft^2	1.2272	1.7671	
13. Wetted perimeter, p_w ... ft	3.927	4.7124	
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ... ft	0.3125	0.3750	
15. Channel slope, s ... ft/ft	0.005	0.006	
16. Manning's roughness coefficient, n	0.013	0.013	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ... ft/sec	3.7322	4.6167	
18. Flow length, L ... ft	380	85	
11. $T_t = \frac{L}{3600\ V}$ Compute T_t ... hr	0.0283 +	0.0051 =	0.0334
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) ... hr			0.2300


AREA 9
1.29 ACRES
OUTFALL #9
EX 54" SD
CHANNEL FLOW 490 LF, 18" SD S= 0.010
CHANNEL FLOW 710 LF, 18" SD AVG S=0.005
PAVEMENT FLOW 205 LF AVG S= 0.005
INITIAL TIME =5 MIN.
PROPOSED OUTFALL #9

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 9	Check one: ☐ Present ☑ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

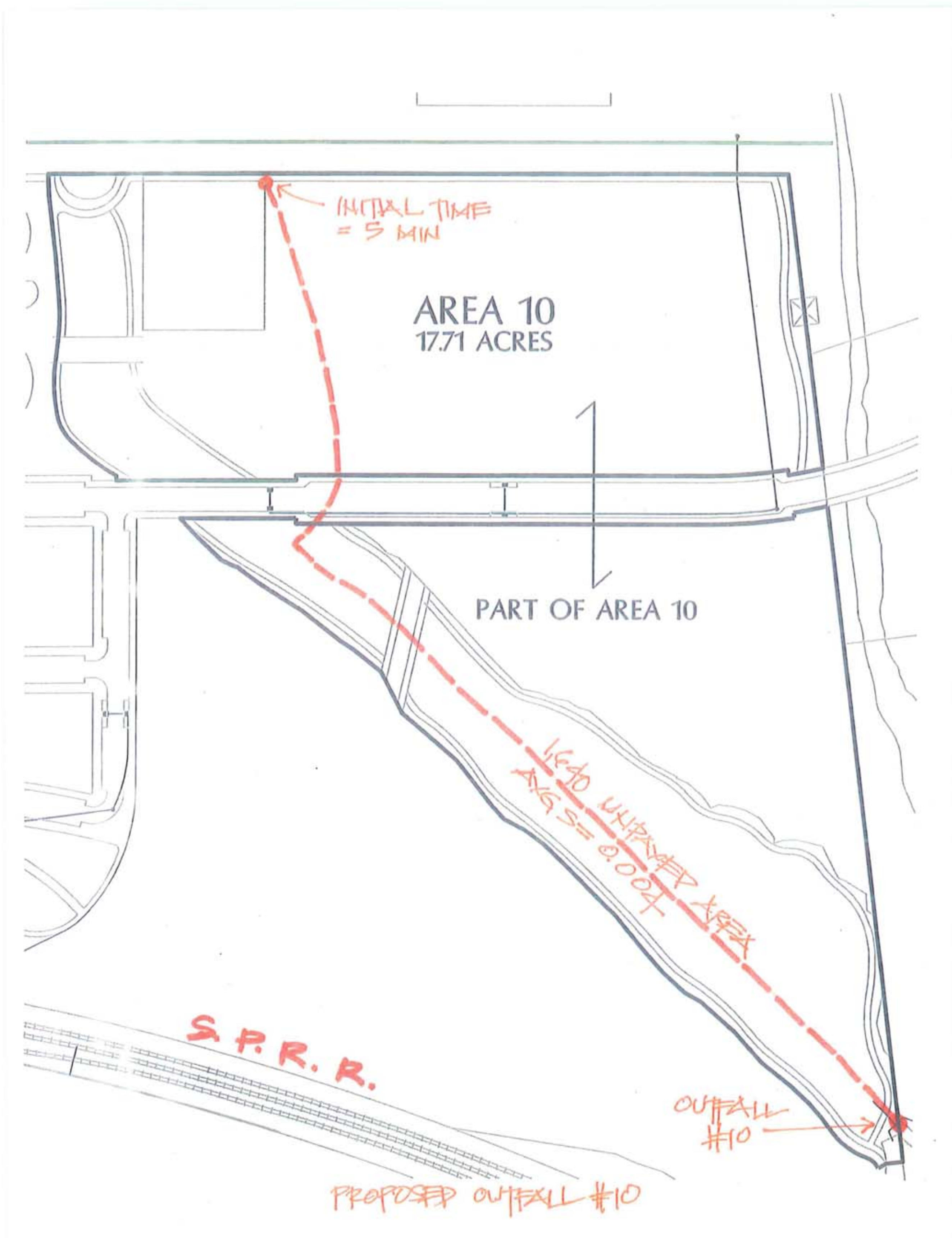
Segment ID	1			
1. Surface description (table 3-1)	Initial Time	5 Minutes		
2. Manning's roughness coefficient, n (table3-1)	0.15	(Roof		
3. Flow length, L (total L, 300 ft) . . . ft	40	to		
4. Two-year 24-hour rainfall, P_2 . . . in	3	Gutter)		
5. Land slope, s . . . ft/ft	0.0186			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t . . . hr	0.0834	+	=	0.0834

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Paved Area			
8. Flow length, L . . . ft	205			
9. Watercourse slope, s . . . ft/ft	0.005			
10. Average velocity, V (figure 3-1) . . . ft/sec	1.1409			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr	0.0499	+	=	0.0499

CHANNEL FLOW

Segment ID	3	4		
12. Cross sectional flow area, a . . . ft²	1.2272	1.7671		
13. Wetted perimeter, p_w . . . ft	3.927	4.7124		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . . ft	0.3125	0.3750		
15. Channel slope, s . . . ft/ft	0.005	0.01		
16. Manning's roughness coefficient, n	0.013	0.013		
17. $V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec	3.7322	5.9601		
18. Flow length, L . . . ft	710	490		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr	0.0528	+ 0.0228	=	0.0757
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.2090


INITIAL TIME
= 5 MIN
AREA 10
17.71 ACRES
PART OF AREA 10
S.P.R.R.
OUTFALL
#10
PROPOSED OUTFALL #10

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

Project	Napa Pipe Redevelopment	By	Ray	Date	3/3/2009
Location	Napa, California	Checked		Date	
Subshed name	Proposed Watershed - Outfall 10	Check one:	☐ Present	☑ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		Check one:	☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

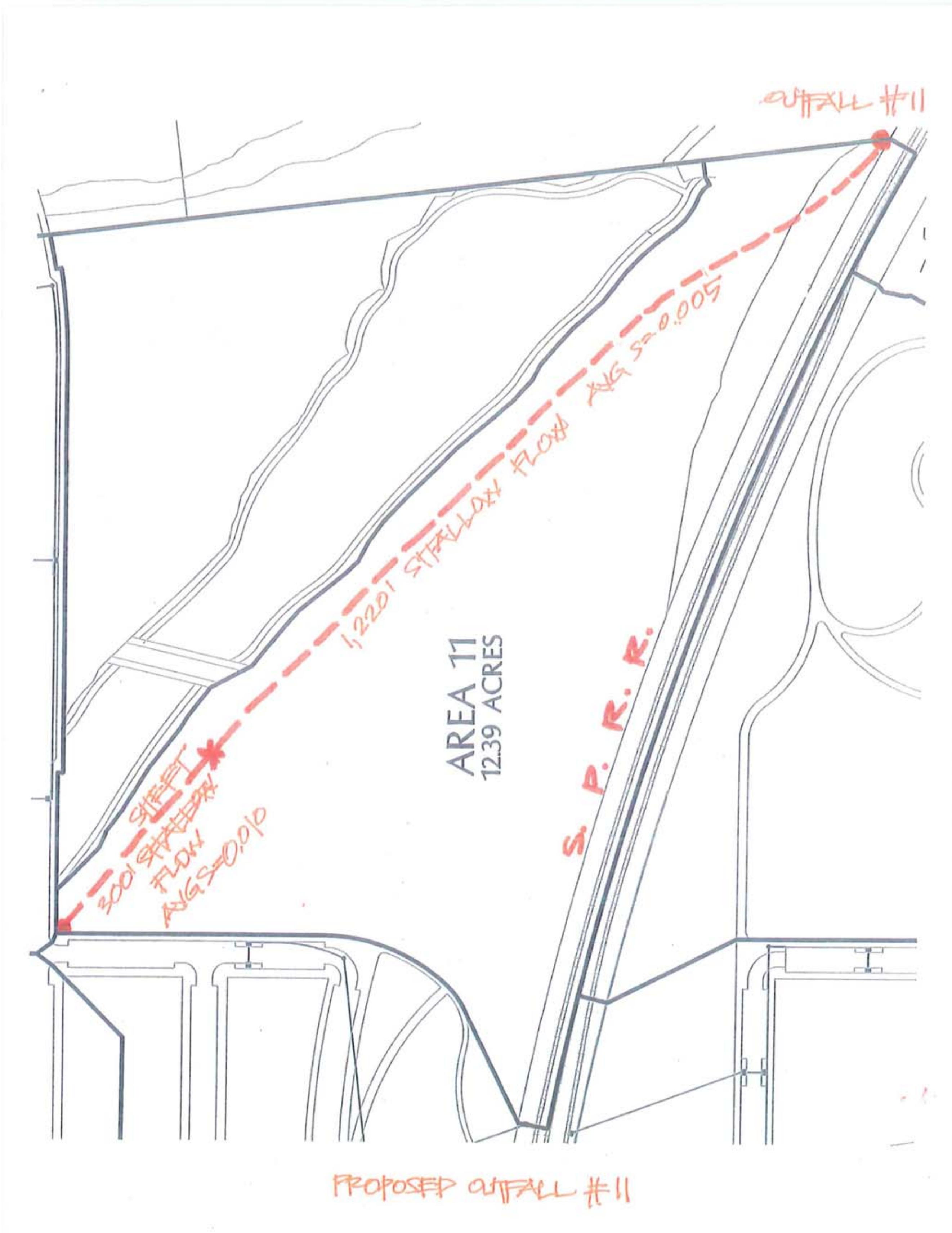
Segment ID		1			
1. Surface description (table 3-1)		Initial Time	5 Minutes (Roof to Ground)		
2. Manning's roughness coefficient, n (table3-1)		0.15			
3. Flow length, L (total L, 300 ft)	ft	40			
4. Two-year 24-hour rainfall, P_2	in	3			
5. Land slope, s	ft/ft	0.0186			
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.0834	+	=	0.0834

SHALLOW CONCENTRATED FLOW

Segment ID		2			
7. Surface description (paved or unpaved)		Unpaved Area			
8. Flow length, L	ft	1640			
9. Watercourse slope, s	ft/ft	0.0035			
10. Average velocity, V (figure 3-1)	ft/sec	0.9545			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.4773	+	=	0.4773

CHANNEL FLOW

Segment ID					
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft				
16. Manning's roughness coefficient, n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/sec				
18. Flow length, L	ft				
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+	=	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19)	hr				0.5607


OUTFALL #11
1,220' SHALLOW FLOW AVG S=0.005
SHEET
300' SHALLOW FLOW AVG S=0.010
AREA 11
12.39 ACRES
S. P. R. R.
PROPOSED OUTFALL #11

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked:	Date:	
Subshed name: Proposed Watershed - Outfall 11	Check one: ☐ Present ☑ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

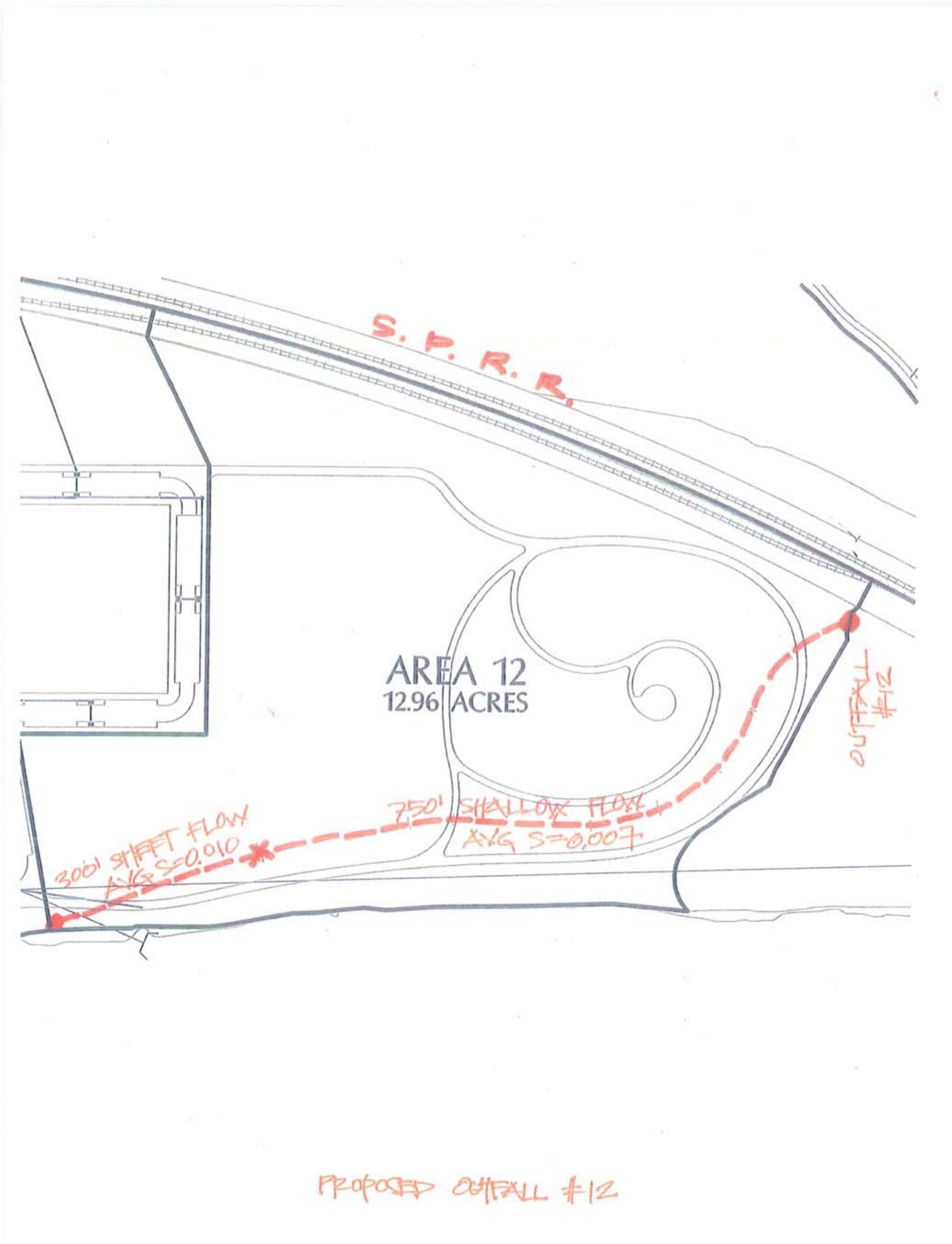
Segment ID	1			
1. Surface description (table 3-1)	Unpaved Area			
2. Manning's roughness coefficient, n (table3-1)	0.15			
3. Flow length, L (total L, 300 ft) . . . ft	300			
4. Two-year 24-hour rainfall, P_2 . . . in	3			
5. Land slope, s . . . ft/ft	0.01			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t . . hr	0.5359	+	=	0.5359

SHALLOW CONCENTRATED FLOW

Segment ID	2			
7. Surface description (paved or unpaved)	Dense Grass			
8. Flow length, L . . . ft	1220			
9. Watercourse slope, s . . . ft/ft	0.005			
10. Average velocity, V (figure 3-1) . . . ft/sec	1.1409			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t . . hr	0.2970	+	=	0.2970

CHANNEL FLOW

Segment ID				
12. Cross sectional flow area, a . . . ft²				
13. Wetted perimeter, p_w . . . ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft				
15. Channel slope, s . . . ft/ft				
16. Manning's roughness coefficient, n . . .				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V . ft/sec				
18. Flow length, L . . . ft				
11. $T_t = \frac{L}{3600\ V}$ Compute T_t . . hr		+	=	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.8330


S.P.R.R.
AREA 12
12.96 ACRES
300' SHEET FLOW
AVG S=0.010
750' SHALLOW FLOW
AVG S=0.007
OUTFALL #12
PROPOSED OUTFALL #12

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 12	Check one: ☐ Present ☑ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

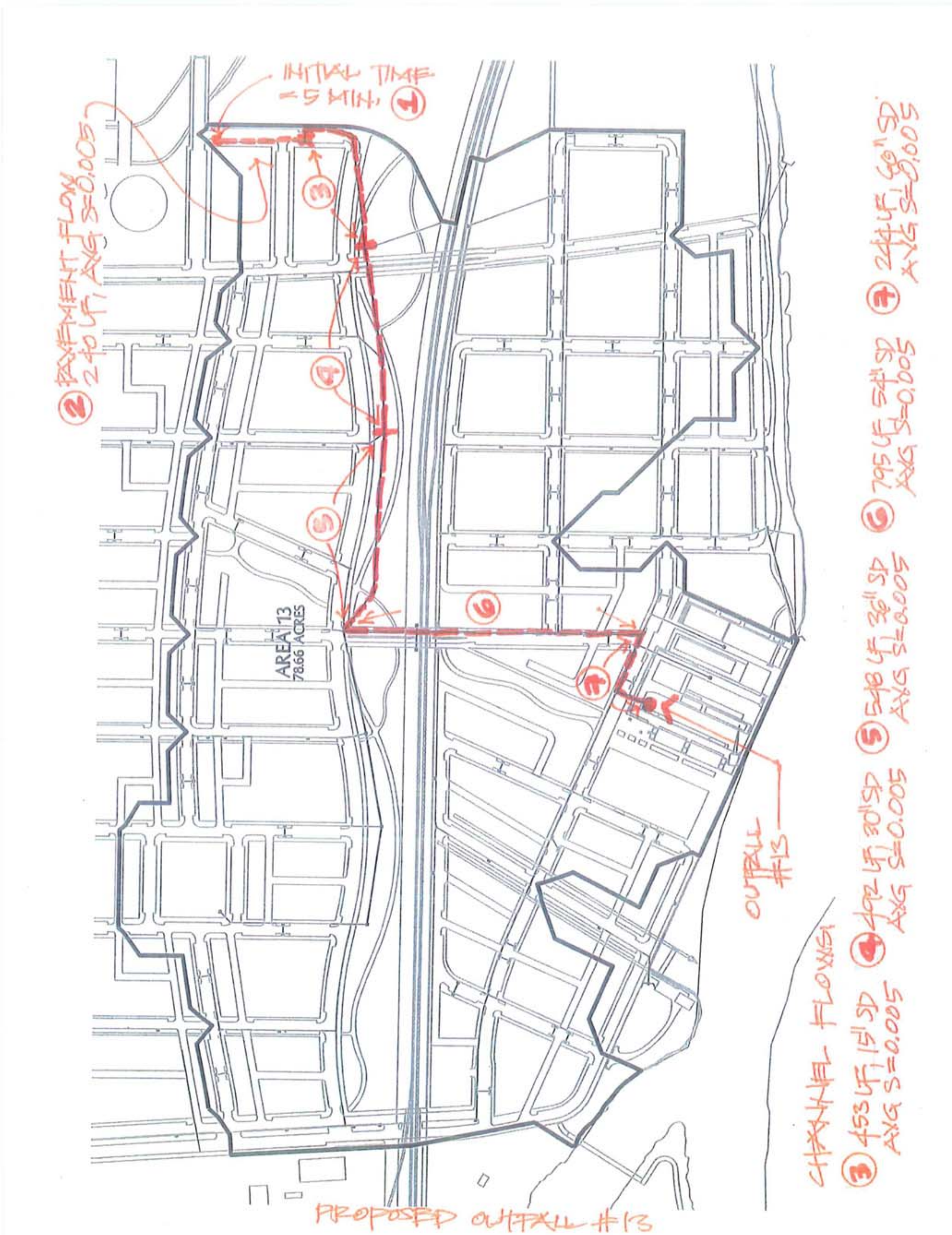
Segment ID	1		
1. Surface description (table 3-1)	Unpaved Area		
2. Manning's roughness coefficient, n (table3-1)	0.15		
3. Flow length, L (total L, 300 ft) . . . ft	300		
4. Two-year 24-hour rainfall, P_2 . . . in	3		
5. Land slope, s . . . ft/ft	0.01		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\; s^{0.4}}$ Compute T_t . . . hr	0.5359	+	= 0.5359

SHALLOW CONCENTRATED FLOW

Segment ID	2		
7. Surface description (paved or unpaved)	Grass		
8. Flow length, L . . . ft	750		
9. Watercourse slope, s . . . ft/ft	0.007		
10. Average velocity, V (figure 3-1) . . . ft/sec	1.3499		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr	0.1543	+	= 0.1543

CHANNEL FLOW

Segment ID			
12. Cross sectional flow area, a . . . ft²			
13. Wetted perimeter, p_w . . . ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft			
15. Channel slope, s . . . ft/ft			
16. Manning's roughness coefficient, n			
17. $V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec			
18. Flow length, L . . . ft			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr		+	=
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr			0.6903


INITIAL TIME =5 MIN. 1
2 PAVEMENT FLOW 240 LF, AVG S=0.005
AREA 13
78.66 ACRES
OUTFALL #13
CHANNEL FLOWS:
3 453 LF, 15" SD AVG S=0.005
4 402 LF, 30" SD AVG S=0.005
5 548 LF, 36" SD AVG S=0.005
6 795 LF, 54" SD AVG S=0.005
7 244 LF, 60" SD AVG S=0.005
PROPOSED OUTFALL #13

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked:	Date:	
Subshed name: Proposed Watershed - Outfall 13 (Sht 1)	Check one: ☐ Present ☑ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

Segment ID	1		
1. Surface description (table 3-1)	Initial Time	5 Minutes (Roof to Gutter)	
2. Manning's roughness coefficient, n (table3-1)	~~0.15~~		
3. Flow length, L (total L, 300 ft) . . . ft	~~40~~		
4. Two-year 24-hour rainfall, P_2 . . . in	~~3~~		
5. Land slope, s . . . ft/ft	~~0.0186~~		
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} \; s^{0.4}}$ Compute T_t . . hr	0.0834	+	= 0.0834

SHALLOW CONCENTRATED FLOW

Segment ID	2		
7. Surface description (paved or unpaved)	Paved Area		
8. Flow length, L . . . ft	240		
9. Watercourse slope, s . . . ft/ft	0.005		
10. Average velocity, V (figure 3-1) . . . ft/sec	1.1409		
11. $T_t = \frac{L}{3600 V}$ Compute T_t . . hr	0.0584	+	= 0.0584

CHANNEL FLOW

Segment ID	3	4	
12. Cross sectional flow area, a . . . ft²	1.2272	4.9087	
13. Wetted perimeter, p_w . . . ft	3.927	7.854	
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.3125	0.6250	
15. Channel slope, s . . . ft/ft	0.005	0.005	
16. Manning's roughness coefficient, n	0.013	0.013	
17. $V = \frac{1.49 \, r^{2/3} s^{1/2}}{n}$ Compute V . ft/sec	3.7322	5.9244	
18. Flow length, L . . . ft	453	492	
11. $T_t = \frac{L}{3600 V}$ Compute T_t . . hr	0.0337	+ 0.0231	= 0.0568
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr			0.1986

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 13 (Sht 2)	Check one: ☐ Present ☑ Developed		
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc ☐ Tt through subarea		

SHEET FLOW (applicable to Tc only)

Segment ID				
1. Surface description (table 3-1)				
2. Manning's roughness coefficient, n (table3-1)				
3. Flow length, L (total L, 300 ft) . . . ft				
4. Two-year 24-hour rainfall, P_2 . . . in				
5. Land slope, s . . . ft/ft				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\; s^{0.4}}$ Compute T_t . . . hr		+		=

SHALLOW CONCENTRATED FLOW

Segment ID				
7. Surface description (paved or unpaved)				
8. Flow length, L . . . ft				
9. Watercourse slope, s . . . ft/ft				
10. Average velocity, V (figure 3-1) . . . ft/sec				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr		+		=

CHANNEL FLOW

Segment ID	5		6		
12. Cross sectional flow area, a . . . ft²	7.0686		15.904		
13. Wetted perimeter, p_w . . . ft	9.4248		14.1372		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	0.7500		1.1250		
15. Channel slope, s . . . ft/ft	0.005		0.005		
16. Manning's roughness coefficient, n . . .	0.013		0.013		
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V . ft/sec	6.6901		8.7664		
18. Flow length, L . . . ft	548		795		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . . hr	0.0228	+	0.0252	=	0.0479
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr					0.0479

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

Project: Napa Pipe Redevelopment	By: Ray	Date: 3/3/2009	
Location: Napa, California	Checked	Date	
Subshed name: Proposed Watershed - Outfall 13 (Sht 3)	Check one: ☐ Present	☑ Developed	
Note: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.	Check one: ☑ Tc	☐ Tt through subarea	

SHEET FLOW (applicable to Tc only)

Segment ID				
1. Surface description (table 3-1)				
2. Manning's roughness coefficient, n (table3-1)				
3. Flow length, L (total L, 300 ft) . . . ft				
4. Two-year 24-hour rainfall, P_2 . . . in				
5. Land slope, s . . . ft/ft				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\; s^{0.4}}$ Compute T_t . . hr		+		=

SHALLOW CONCENTRATED FLOW

Segment ID				
7. Surface description (paved or unpaved)				
8. Flow length, L . . . ft				
9. Watercourse slope, s . . . ft/ft				
10. Average velocity, V (figure 3-1) . . . ft/sec				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr		+		=

CHANNEL FLOW

Segment ID	7			
12. Cross sectional flow area, a . . . ft^2	19.635			
13. Wetted perimeter, p_w . . . ft	15.708			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r . . ft	1.2500			
15. Channel slope, s . . . ft/ft	0.005			
16. Manning's roughness coefficient, n . . .	0.013			
17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V . ft/sec	9.4045			
18. Flow length, L . . . ft	244			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t . . hr	0.0072	+		= 0.0072
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19) . . . hr				0.0072

TOTAL Tc = 0.1986 + 0.0479 + 0.0072 = 0.2537

Appendix C

Site Hydrographs

NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #1)

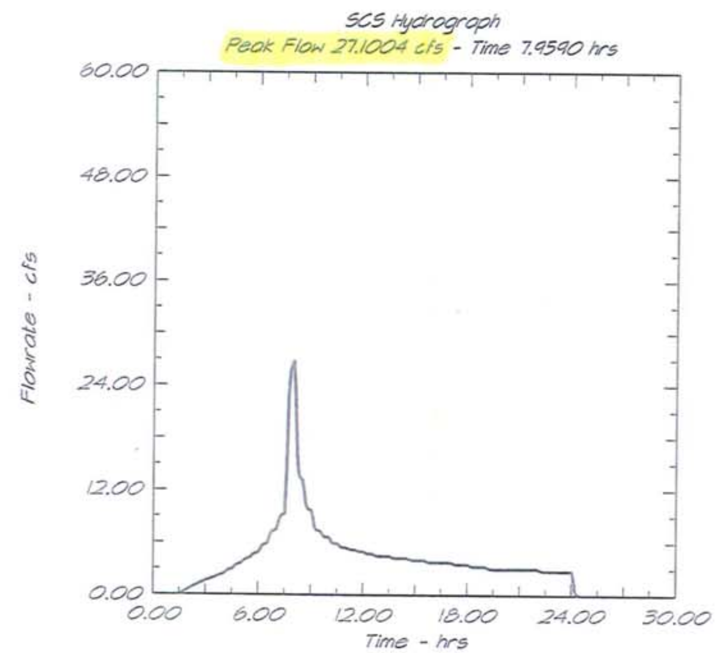
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #1
Drainage area .... 21.4100 ac
Runoff curve number, CN 91
Time of concentration, Tc .... 0.1839 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 27.1004 cfs
Peak Time, Tp .... 7.9590 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9543 in
.... 106.9610 cfs-hrs
.... 8.8393 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #2)

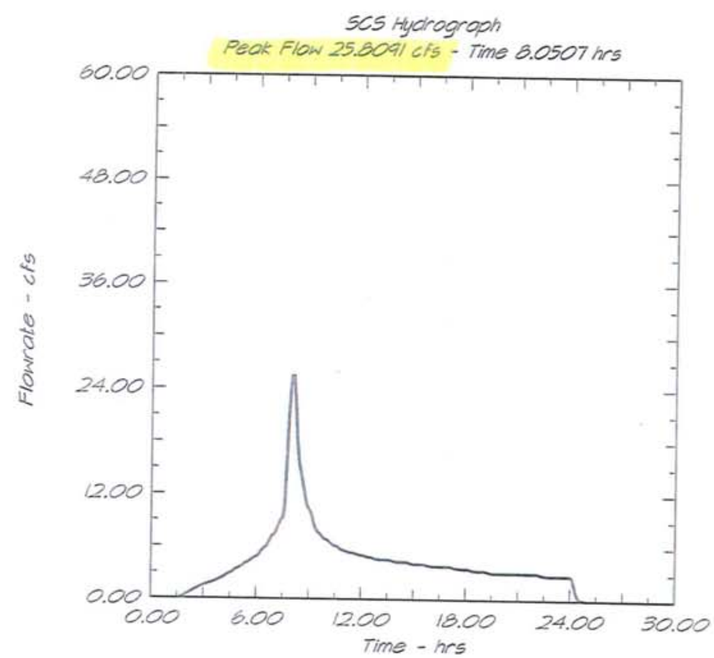
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #2
Drainage area .... 21.8500 ac
Runoff curve number, CN 91
Time of concentration, Tc ...... 0.3553 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 25.8091 cfs
Peak Time, Tp .... 8.0507 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9539 in
.... 109.1502 cfs-hrs
.... 9.0202 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #3)

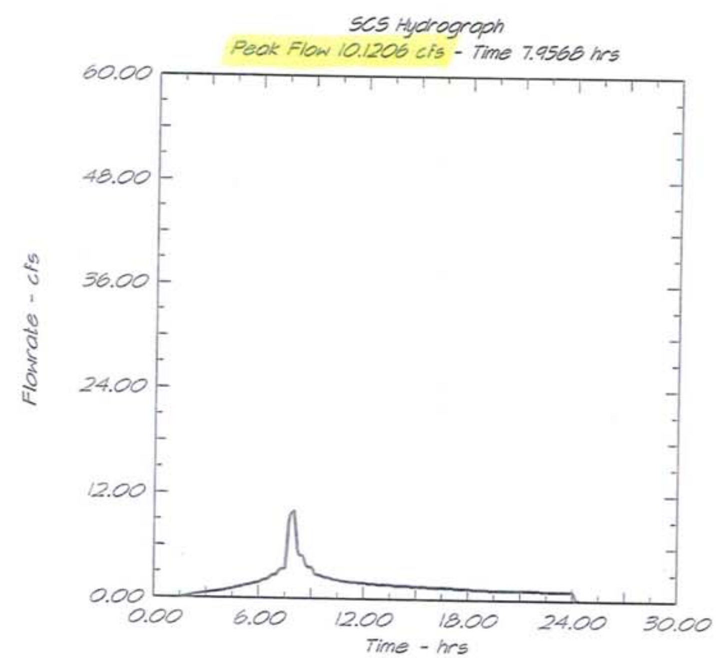
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #3
Drainage area .... 7.9300 ac
Runoff curve number, CN 91
Time of concentration, Tc .... 0.1667 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 10.1206 cfs
Peak Time, Tp .... 7.9568 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9529 in
.... 39.6058 cfs-hrs
.... 3.2730 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #4)

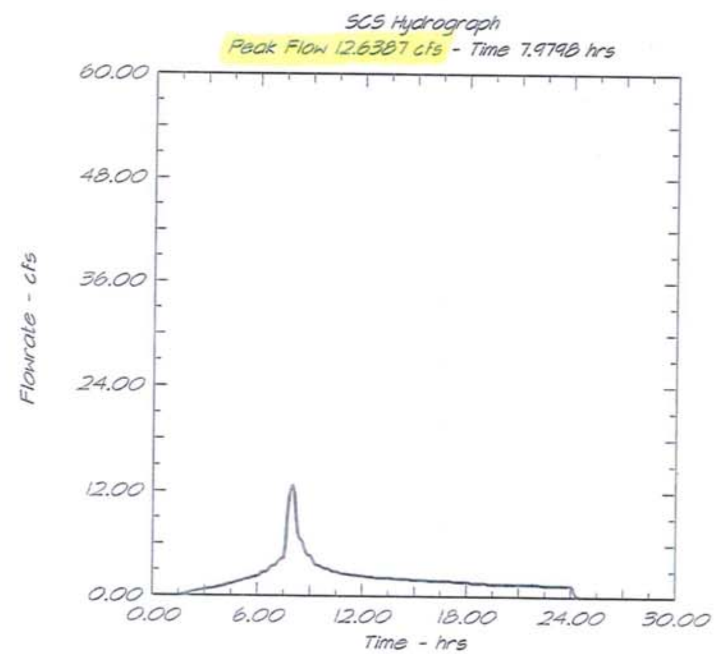
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #4
Drainage area .... 10.2500 ac
Runoff curve number, CN 91
Time of concentration, Tc .... 0.2450 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 12.6387 cfs
Peak Time, Tp .... 7.9798 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9547 in
.... 51.2120 cfs-hrs
.... 4.2522 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #5)

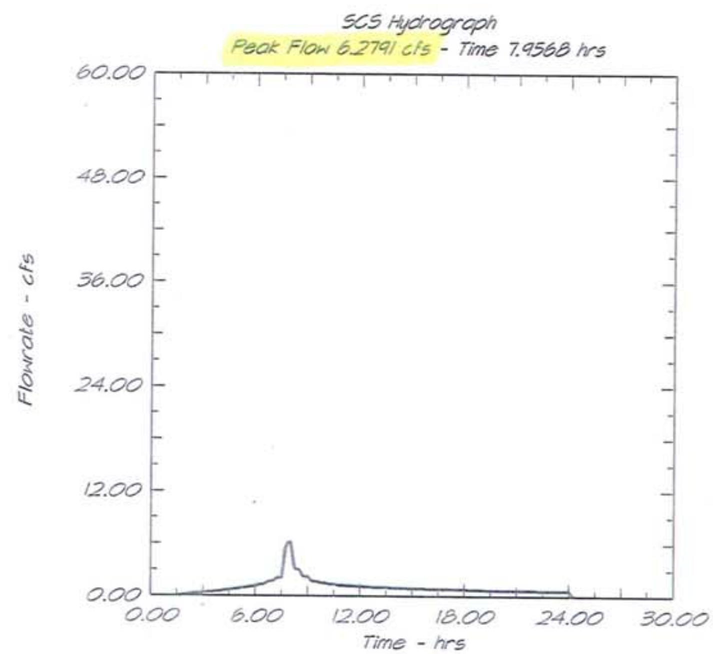
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #5
Drainage area .... 4.9200 ac
Runoff curve number, CN 91
Time of concentration, Tc .... 0.1667 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 6.2791 cfs
Peak Time, Tp .... 7.9568 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9527 in
.... 24.5716 cfs-hrs
.... 2.0306 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #6)

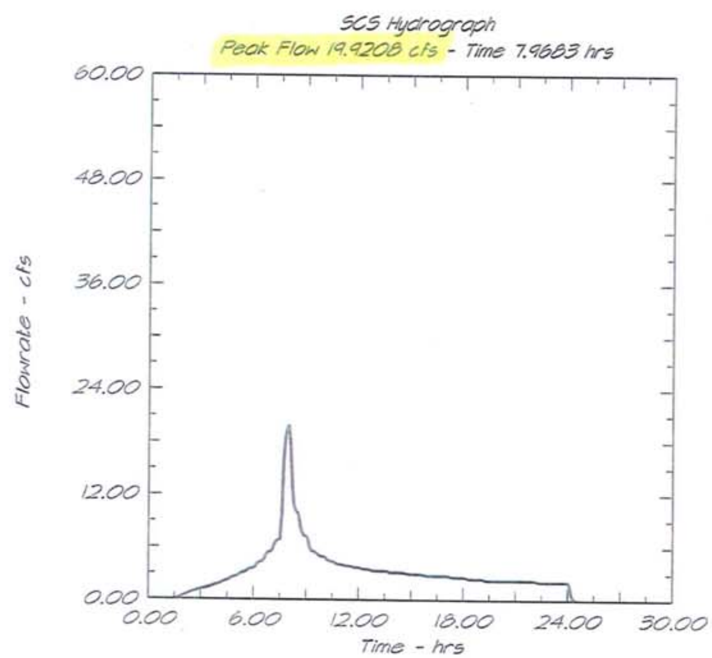
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description	100 yr Pre-developed Outfall #6
Drainage area	15.9600 ac
Runoff curve number, CN	91
Time of concentration, Tc	0.2181 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t3: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	19.9208 cfs
Peak Time, Tp	7.9683 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.9547 in
	79.7399 cfs-hrs
	6.5897 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #7)

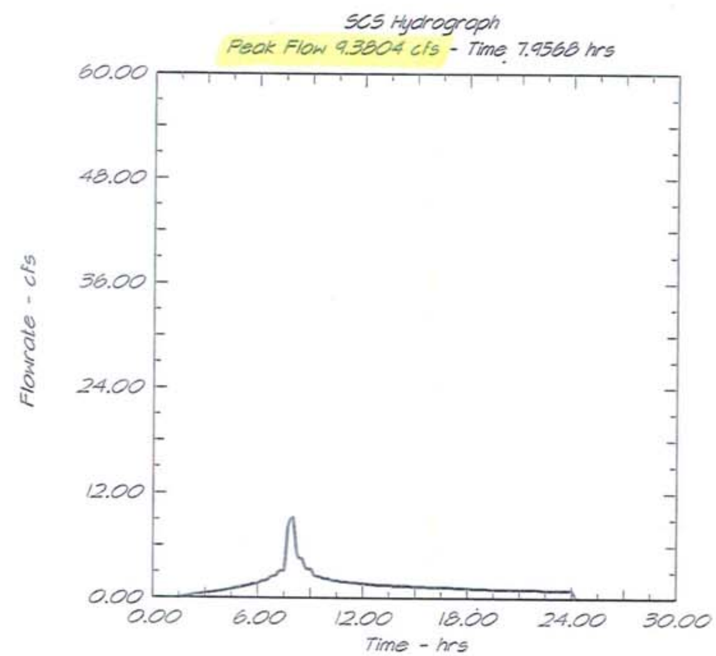
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #7
Drainage area .... 7.3500 ac
Runoff curve number, CN 91
Time of concentration, Tc .... 0.1667 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 9.3804 cfs
Peak Time, Tp .... 7.9568 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9529 in
.... 36.7090 cfs-hrs
.... 3.0336 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #8)

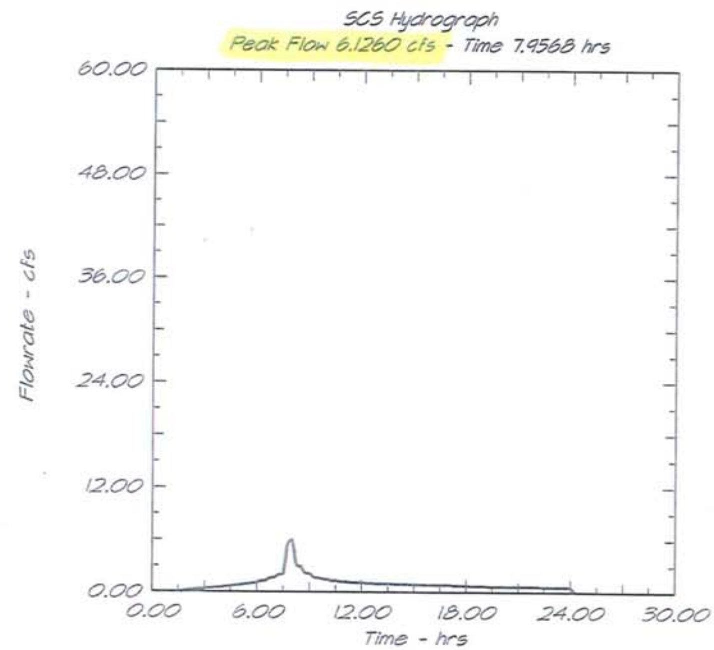
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #8
Drainage area .... 4.8000 ac
Runoff curve number, CN 91
Time of concentration, Tc .... 0.1667 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 6.1260 cfs
Peak Time, Tp .... 7.9568 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9527 in
.... 23.9723 cfs-hrs
.... 1.9811 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #9)

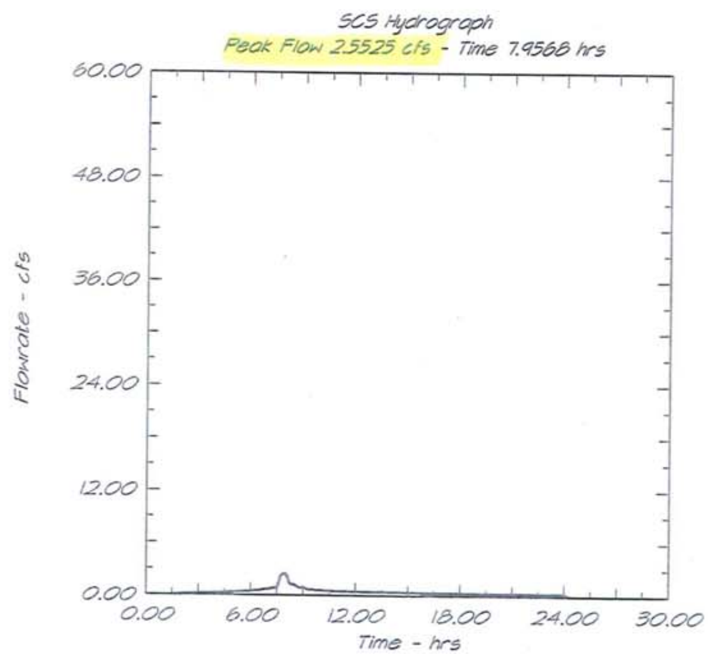
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description	100 yr Pre-developed Outfall #9
Drainage area	2.0000 ac
Runoff curve number, CN	91
Time of concentration, Tc	0.1667 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t3: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	2.5525 cfs
Peak Time, Tp	7.9568 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.9527 in
	9.9884 cfs-hrs
	0.8254 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #10)

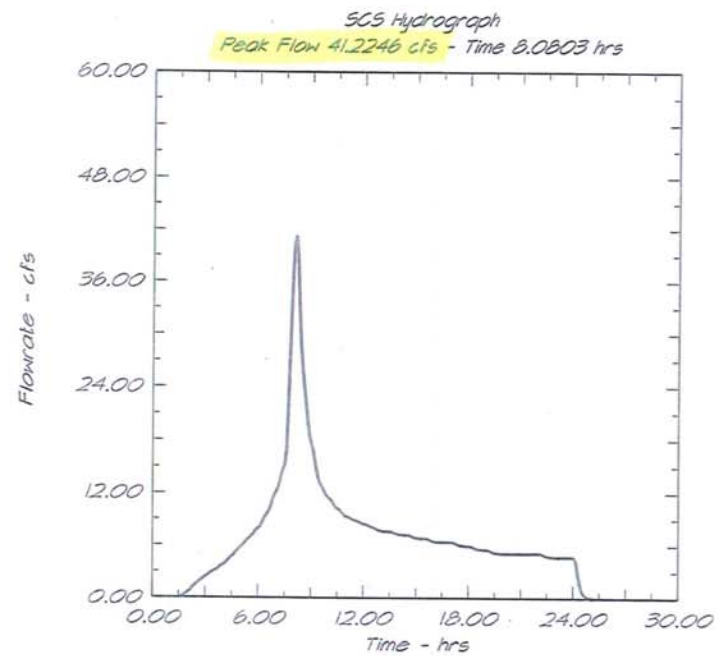
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #10
Drainage area .... 36.4000 ac
Runoff curve number, CN 91
Time of concentration, Tc ...... 0.4267 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 41.2246 cfs
Peak Time, Tp .... 8.0803 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9530 in
.... 181.8030 cfs-hrs
.... 15.0242 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #11)

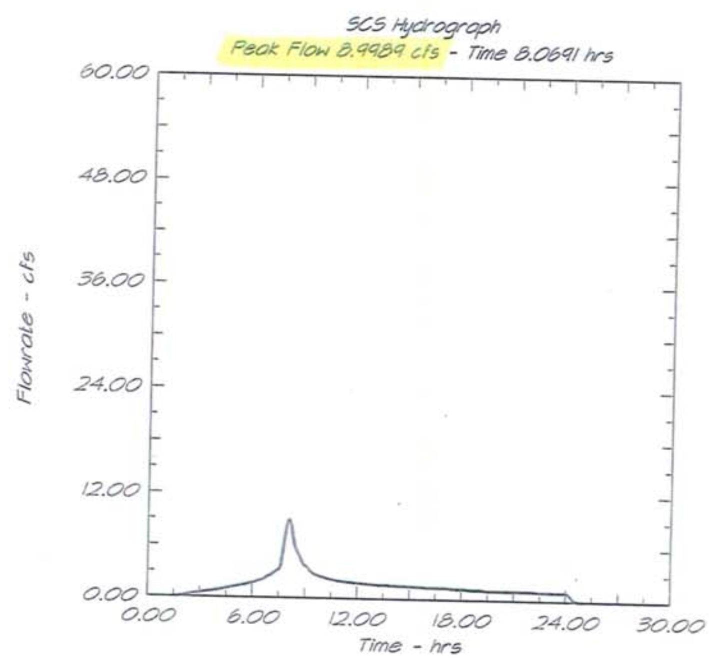
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #11
Drainage area .... 7.8500 ac
Runoff curve number, CN 91
Time of concentration, Tc .... 0.4040 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 8.9989 cfs
Peak Time, Tp .... 8.0691 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9525 in
.... 39.2030 cfs-hrs
.... 3.2397 acft



NAPA PIPE REDEVELOPMENT

100-year Pre-developed Condition (Outfall #12)

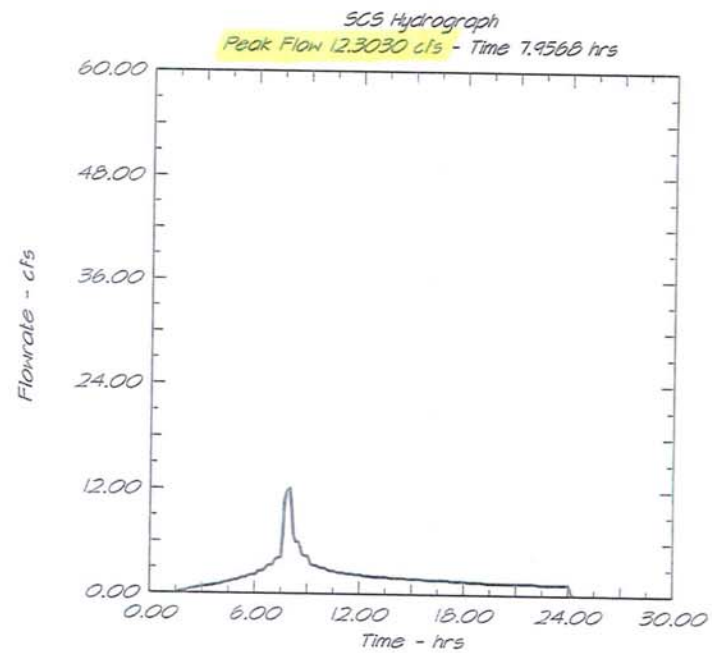
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Pre-developed Outfall #12
Drainage area .... 9.6400 ac
Runoff curve number, CN 91
Time of concentration, Tc .... 0.1667 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 12.3030 cfs
Peak Time, Tp .... 7.9568 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.9529 in
.... 48.1462 cfs-hrs
.... 3.9788 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #1)

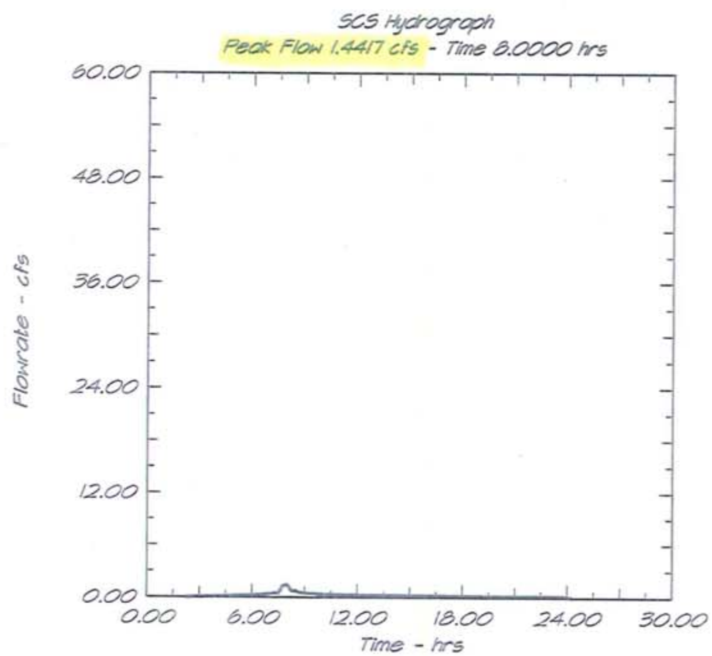
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Post-developed Outfall #1
Drainage area .... 1.2600 ac
Runoff curve number, CN 87
Time of concentration, Tc .... 0.1667 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 1.4417 cfs
Peak Time, Tp .... 8.0000 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.5130 in
.... 5.7340 cfs-hrs



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #2)

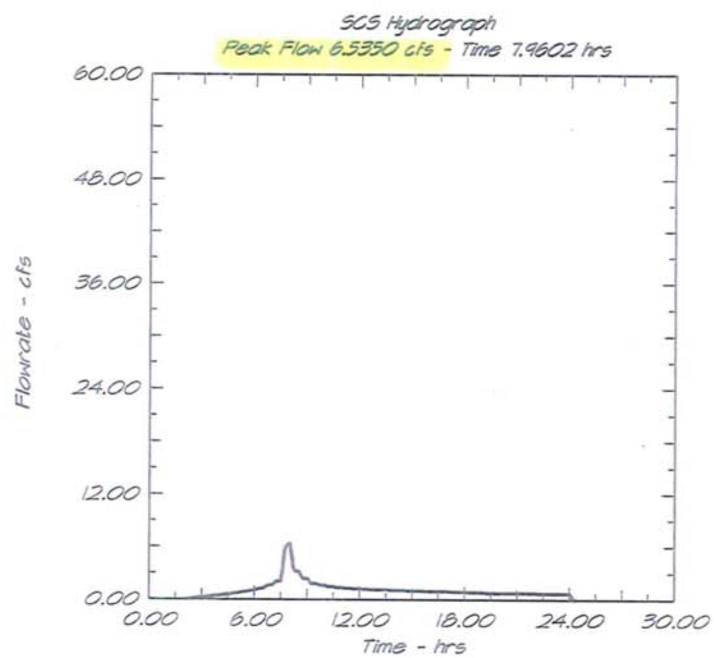
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description	100 yr Post-developed Outfall #2
Drainage area	5.6200 ac
Runoff curve number, CN	87
Time of concentration, Tc	0.1667 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t3: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition ..	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	6.5350 cfs
Peak Time, Tp	7.9602 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.5132 in
....	25.5772 cfs-hrs
....	2.1137 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #3)

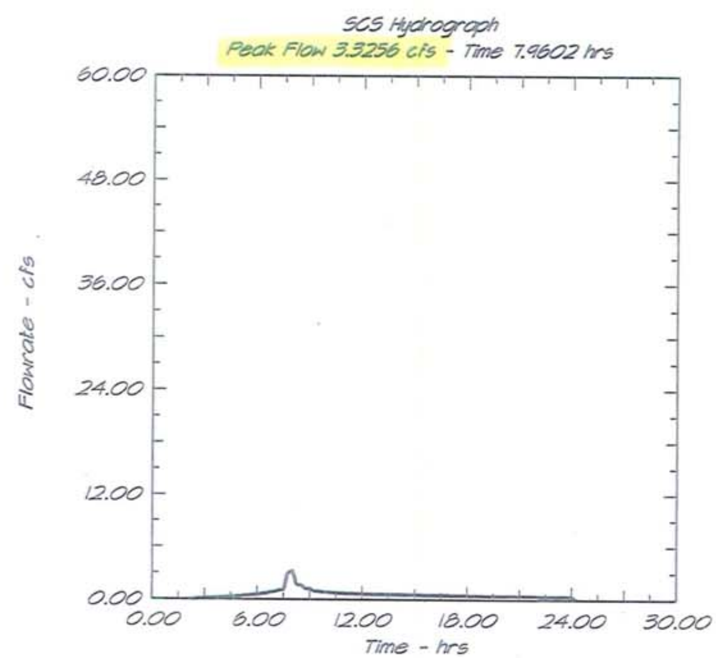
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description	100 yr Post-developed Outfall #3
Drainage area	2.8600 ac
Runoff curve number, CN	87
Time of concentration, Tc	0.1667 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t3: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	3.3256 cfs
Peak Time, Tp	7.9602 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.5130 in
	13.0153 cfs-hrs
	1.0756 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #4)

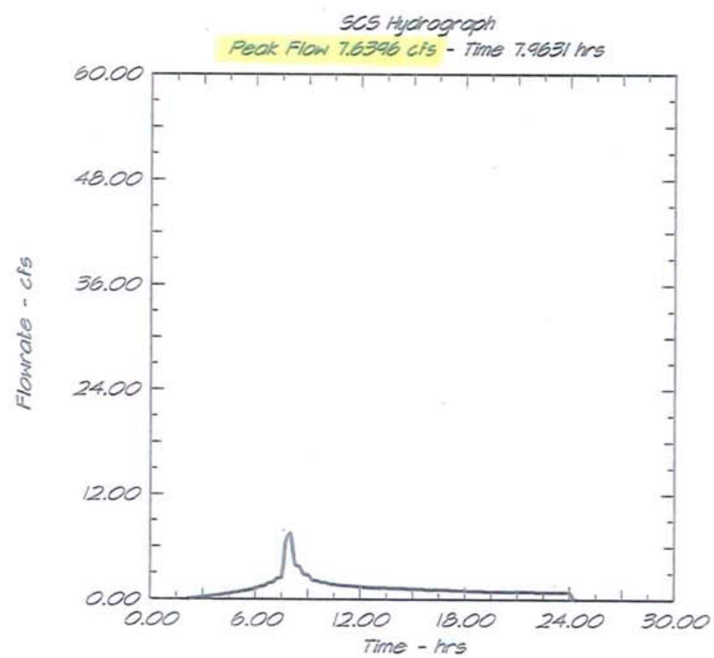
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description	100 yr Post-developed Outfall #4
Drainage area	6.6300 ac
Runoff curve number, CN	87
Time of concentration, Tc	0.1839 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t3: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	7.6396 cfs
Peak Time, Tp	7.9631 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.5145 in
	30.1822 cfs-hrs
	2.4943 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #5)

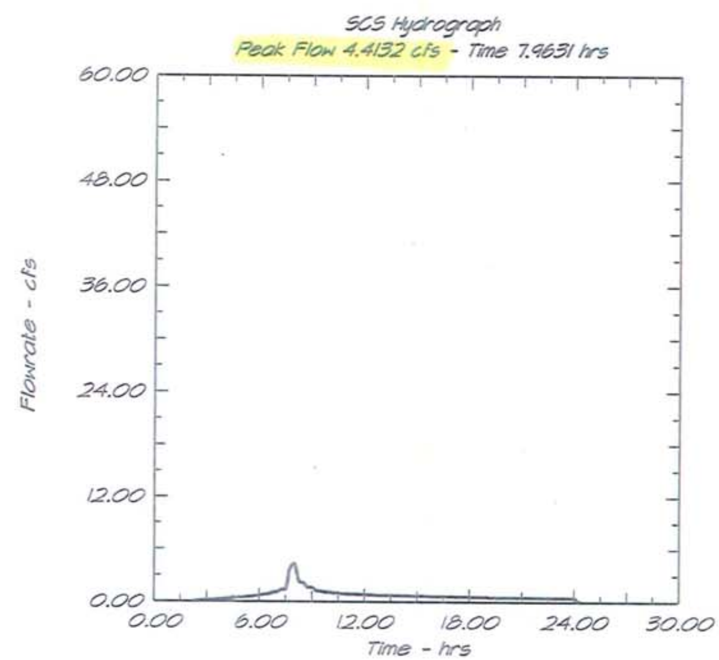
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Post-developed Outfall #5
Drainage area .... 3.3300 ac
Runoff curve number, CN 87
Time of concentration, Tc .... 0.1839 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 4.4132 cfs
Peak Time, Tp .... 7.9631 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.5143 in
.... 17.4349 cfs-hrs
.... 1.4408 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #6)

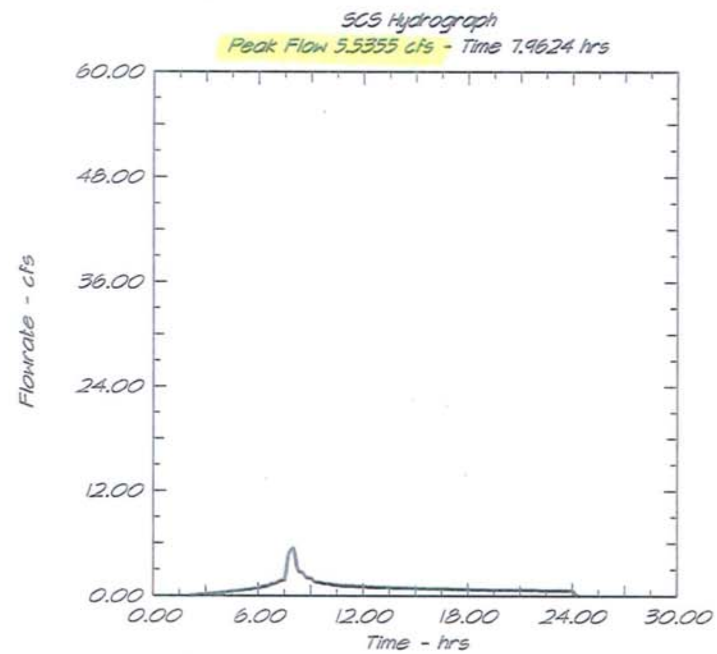
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Post-developed Outfall #6
Drainage area .... 4.8000 ac
Runoff curve number, CN 87
Time of concentration, Tc .... 0.1815 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 5.5355 cfs
Peak Time, Tp .... 7.9624 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.5141 in
.... 21.8496 cfs-hrs
.... 1.8057 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #7)

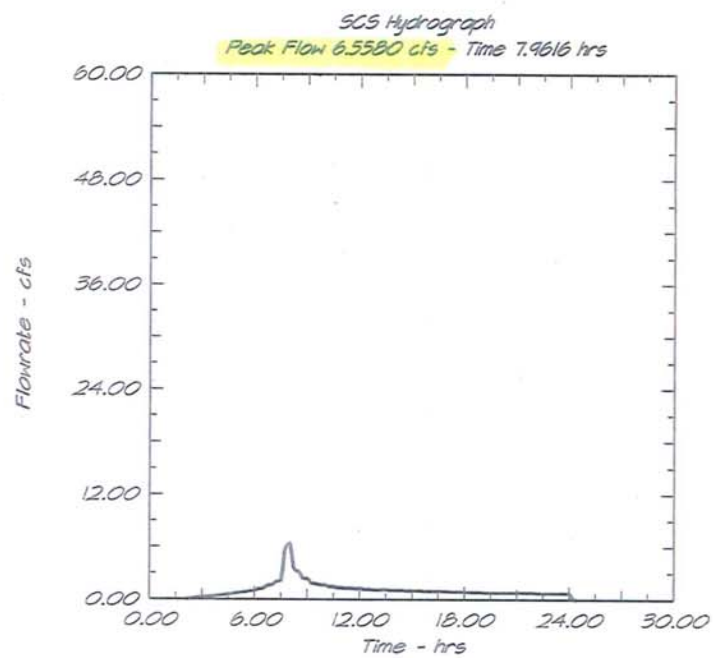
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description	100 yr Post-developed Outfall #7
Drainage area	5.6600 ac
Runoff curve number, CN	87
Time of concentration, Tc	0.1744 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t5: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	6.5580 cfs
Peak Time, Tp	7.9616 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.5139 in
	25.7630 cfs-hrs
	2.1291 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #8)

TR-20 RUNOFF CALCULATION
SCS Method

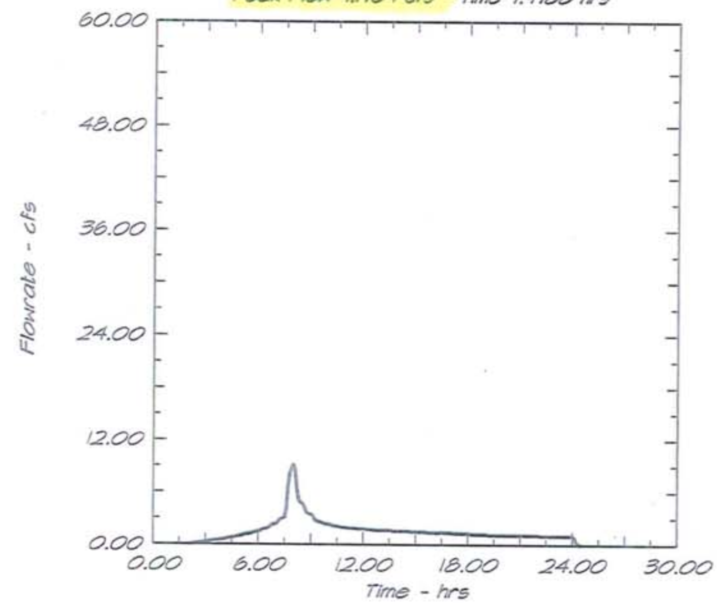
Given Input Data:

Description	100 yr Post-developed Outfall #8
Drainage area	8.1300 ac
Runoff curve number, CN	87
Time of concentration, Tc	0.2300 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t3: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	9.1709 cfs
Peak Time, Tp	7.9788 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.5153 in
	37.0170 cfs-hrs
	3.0591 acft

SCS Hydrograph
Peak Flow 9.1709 cfs - Time 7.9788 hrs



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #9)

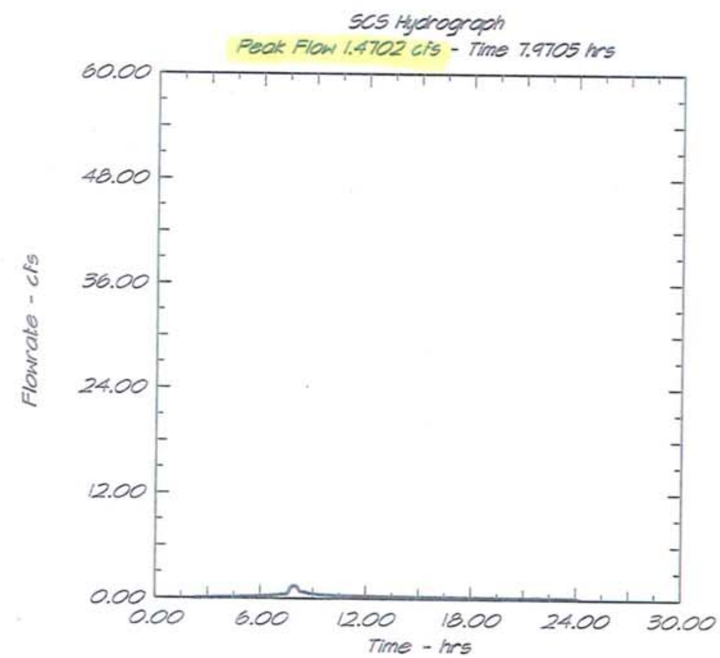
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description	100 yr Post-developed Outfall #9
Drainage area	1.2900 ac
Runoff curve number, CN	87
Time of concentration, Tc	0.2090 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t5: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition ..	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	1.4702 cfs
Peak Time, Tp	7.9705 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.5144 in
....	5.8725 cfs-hrs
....	0.4853 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #10)

TR-20 RUNOFF CALCULATION
SCS Method

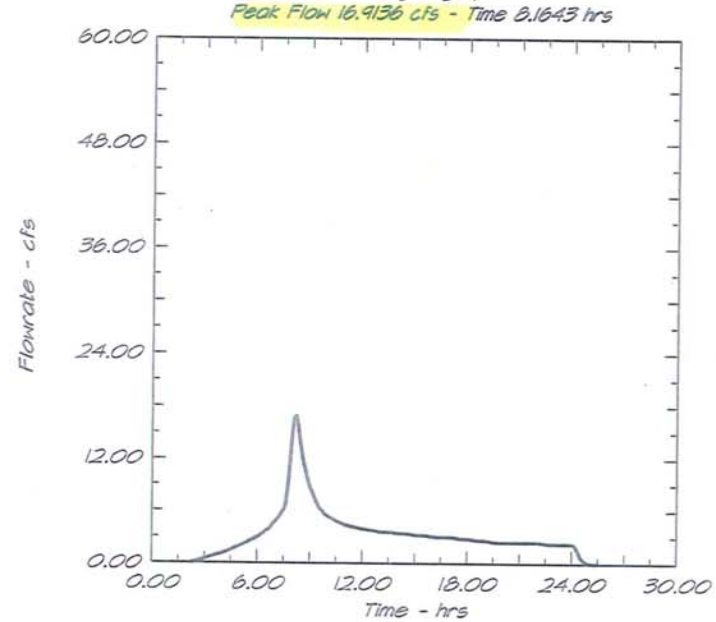
Given Input Data:

Description .... 100 yr Post-developed Outfall #10
Drainage area .... 17.7100 ac
Runoff curve number, CN 87
Time of concentration, Tc .... 0.5607 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 16.9136 cfs
Peak Time, Tp .... 8.1643 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.5129 in
.... 80.5931 cfs-hrs
.... 6.6602 acft

SCS Hydrograph
Peak Flow 16.9136 cfs - Time 8.1643 hrs



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #11)

TR-20 RUNOFF CALCULATION
SCS Method

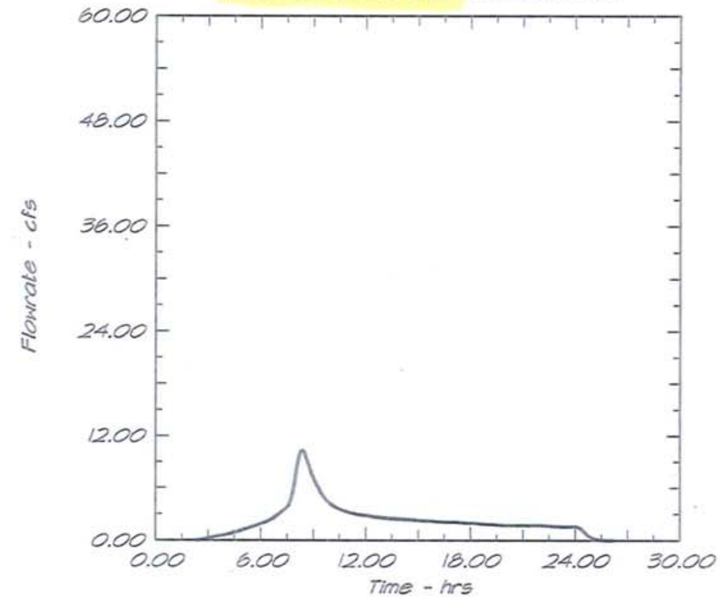
Given Input Data:

Description .... 100 yr Post-developed Outfall #11
Drainage area .... 12.3900 ac
Runoff curve number, CN 87
Time of concentration, Tc .... 0.8330 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 10.3626 cfs
Peak Time, Tp .... 8.3497 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.5128 in
.... 56.3828 cfs-hrs
.... 4.6595 acft

SCS Hydrograph
Peak Flow 10.3626 cfs - Time 8.3497 hrs



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #12)

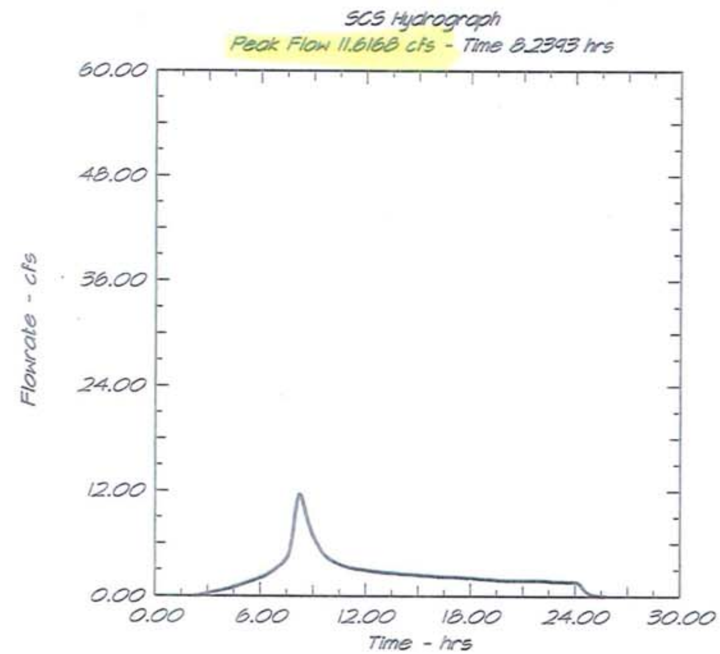
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description .... 100 yr Post-developed Outfall #12
Drainage area .... 12.9600 ac
Runoff curve number, CN 87
Time of concentration, Tc .... 0.6903 hrs
Dimensionless Hydrograph .... scsdim
Rainfall .... 6.0000 in
Distribution Curve .... tr20t3: Type IA, 24 hrs
Duration .... 24.0000 hrs
Antecendent Moisture Condition .. Type II
Time Increment, Tp .... 0.1000 hrs

Computed Results:

Peak discharge, qp .... 11.6168 cfs
Peak Time, Tp .... 8.2393 hrs
Peak rate factor 484
Constant, K 0.7500
Runoff Volume .... 4.5144 in
.... 58.9969 cfs-hrs
.... 4.8755 acft



NAPA PIPE REDEVELOPMENT

100-year Post-developed Condition (Outfall #13)

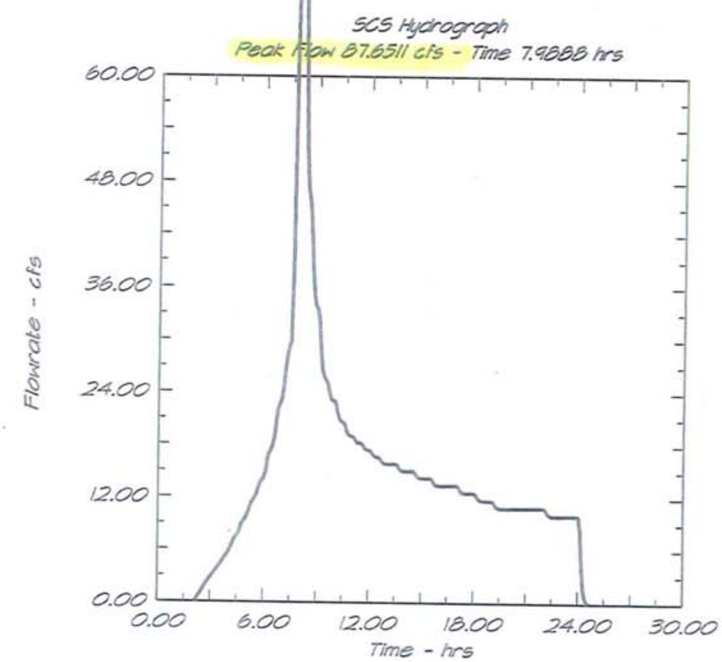
TR-20 RUNOFF CALCULATION
SCS Method

Given Input Data:

Description	100 yr Post-developed Outfall #13
Drainage area	78.6600 ac
Runoff curve number, CN	87
Time of concentration, Tc	0.2537 hrs
Dimensionless Hydrograph	scsdim
Rainfall	6.0000 in
Distribution Curve	tr20t3: Type IA, 24 hrs
Duration	24.0000 hrs
Antecendent Moisture Condition	Type II
Time Increment, Tp	0.1000 hrs

Computed Results:

Peak discharge, qp	87.6511 cfs
Peak Time, Tp	7.9888 hrs
Peak rate factor	484
Constant, K	0.7500
Runoff Volume	4.5144 in
	358.0843 cfs-hrs
	29.5921 acft



Appendix D

Flow Summary Comparison at Outfalls

NAPA PIPE REDEVELOPMENT

100 YR FLOWS AT OUTFALLS

Outfall Area	Pre (cfs)	Post (cfs)
1	27.10	1.44
2	25.81	6.54
3	10.12	3.33
4	12.64	7.64
5	6.28	4.41
6	19.92	5.54
7	9.38	6.56
8	6.13	9.17
9	2.55	1.47
10	41.22	16.91
11	9.00	10.36
12	12.30	11.62
13	None	87.65
TOTAL	182.45	172.64

FLOOD ANALYSIS

FLOOD ANALYSIS

Figure L.1.a - FLOOD DEPTH MAP

NAPA PIPE

FLOOD EXHIBIT PRE DEVELOPMENT

NAPA CALIFORNIA

FLOOD ELEVATIONS		
MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOR
0	8.4	

GRAPHIC SCALE

400 0 400 800

(IN FEET)
1 inch = 400 FT

CONSULTING CIVIL ENGINEERS
RIECHERS SPENCE ASSOCIATES
1515 Fourth Street
Napa, Calif. 94559
v 707.252.3301
f 707.252.4966

November 19, 2013

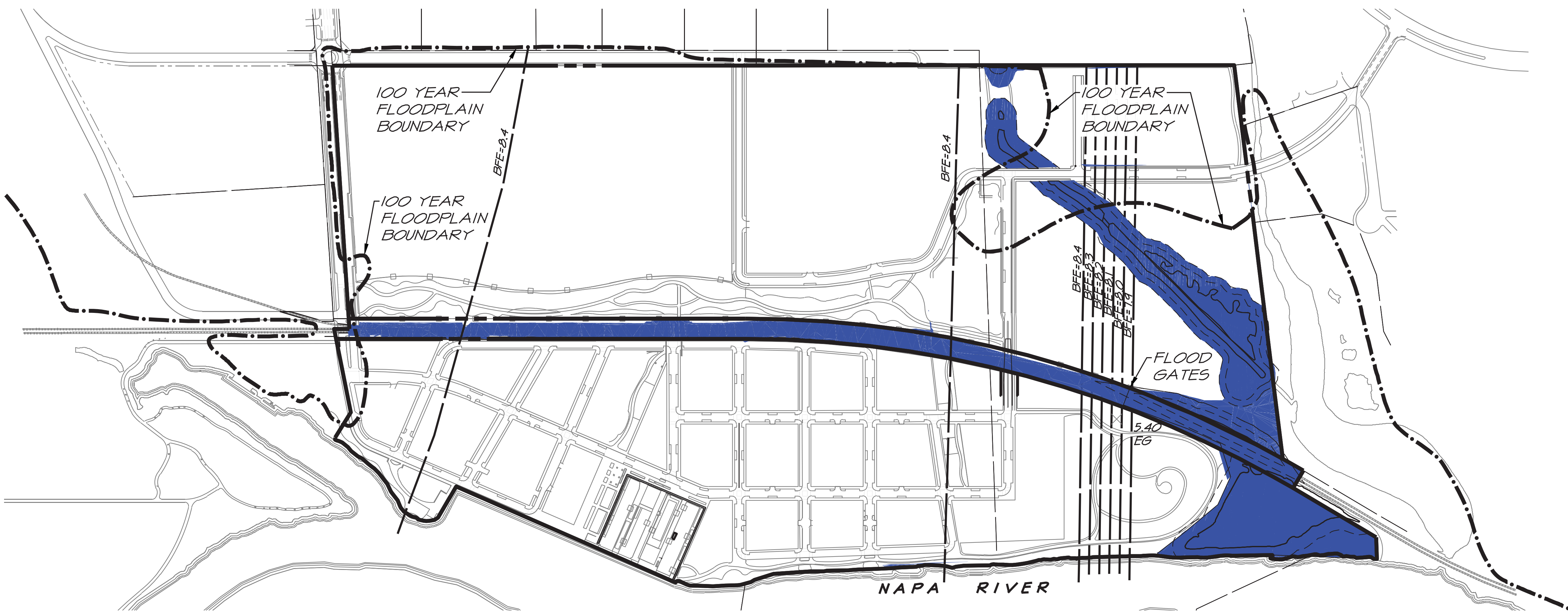
FLOOD ANALYSIS

Figure L.1.b - FLOOD DEPTH MAP

NAPA PIPE

FLOOD EXHIBIT POST DEVELOPMENT FLOOD GATES OPEN

NAPA CALIFORNIA



FLOOD ELEVATIONS		
MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOR
0	8.40	

GRAPHIC SCALE

400 0 400 800

(IN FEET)
1 inch = 400 FT

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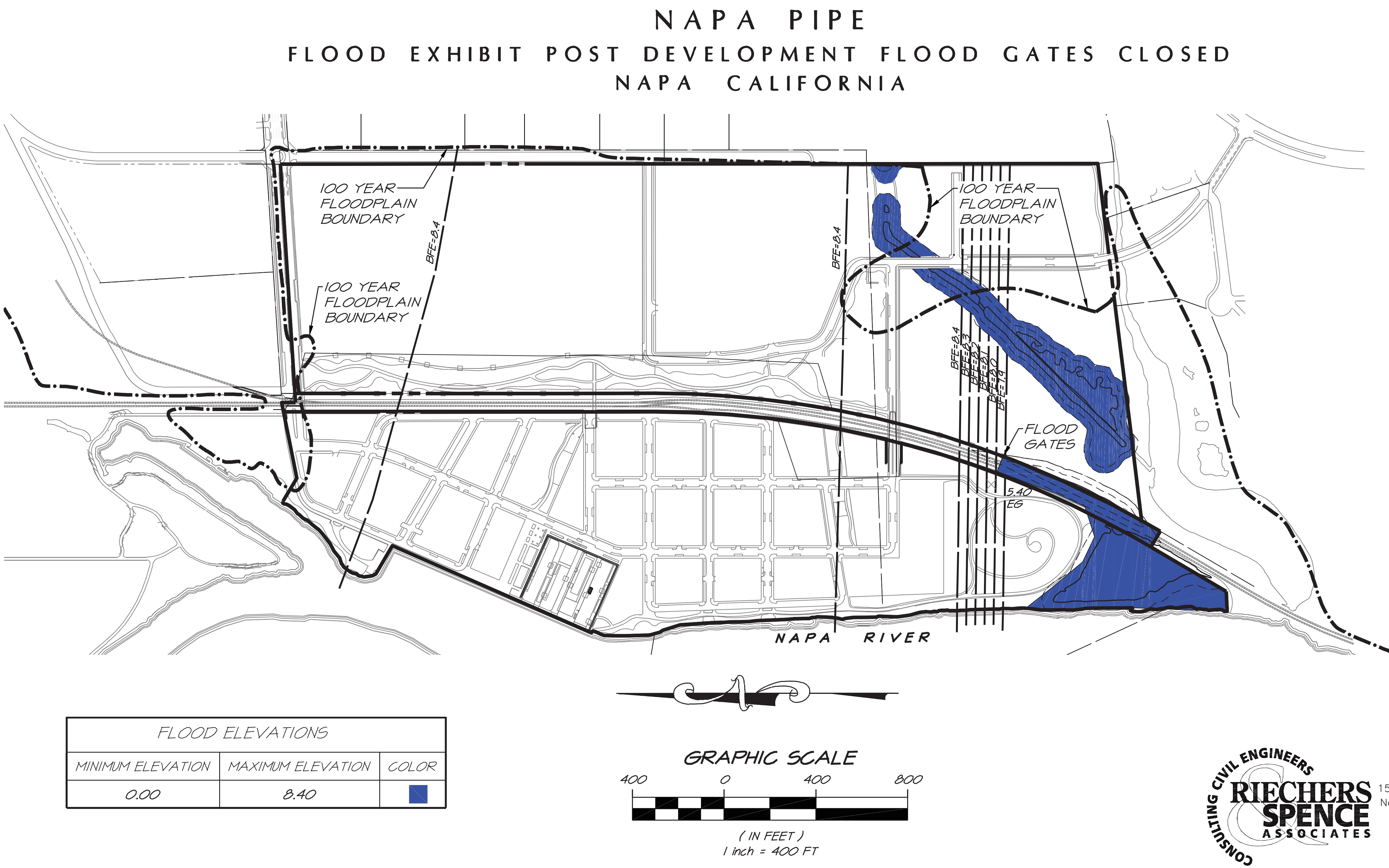
RIECHERS SPENCE ASSOCIATES
1515 Fourth Street
Napa, Calif. 94559
v 707.252.3301
f 707.252.4966

November 19, 2013

FLOOD ANALYSIS

Figure L.1.c - FLOOD DEPTH MAP



FLOOD ELEVATIONS		
MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOR
0.00	8.40	

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November 19, 2013

Exhibit L.2 - FLOOD CONTROL MEMO

1515 Fourth Street
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MEMORANDUM

Job#: 4106029.0
Date: November 7, 2013
To: Flood Control
From: Jeremy Sill/Riechers Spence & Associates
Subject: Napa Pipe Flood Control

This memo is intended to summarize the discussion items based on our field meeting dated November 6, 2013 and subsequent emails. The purpose of the meeting was to review the Napa Pipe site and potential floodgate locations and designs to determine if feasible. Additionally, operations and maintenance of the floodgates was discussed and the results of our discussion are below:

- It is probable that a flood barrier solution can be designed for the north and south ends of the project. Additional research will need to be conducted in order to find an appropriate and dependable option that is acceptable to the Flood District.

- There are a number of "off-the-shelf" products that could be incorporated into the final design. These include:
  - www.portadam.com/cp-projects/flood-protection/
  - www.fluvial-innovations.co.uk/floodstop-09.html
  - www.hydrologicalsolutions.com

- It was pointed out that the railroad tracks are not even from side to side. This will need to be accounted for in the design.

- Flood Control prefers gates that require human power to put in place over mechanical/electrical gates.

- Given the point above, the Napa Pipe Project will fund Flood Control to operate and maintain these flood gates/barriers.

- It was mentioned that a secondary warning light may be useful at the crossings to warn motorists and pedestrians of the water level when the roadway becomes inundated.

In summary, Flood Control and the developer are confident that a flood gate solution is available and the type/size/width/material of gate will be worked out in conjunction with a flood gate designer during the construction document phase of the project. The gates shown on the Tentative Map are one example of a solution that will work. The gates will be operated and maintained through funding by the developer or HOA.

Exhibit L.3 - Excerpt from SUPPLEMENTAL ENVIRONMENTAL ANALYSIS: HYDROLOGY AND WATER QUALITY

J. Hydrology and Water Quality

The Developer's Revised Proposal would impose essentially the same impedance to flood flows from the Napa River throughout the site when compared to the project, and would have similar conditions and impacts in terms of drainage patterns and storm water runoff throughout the site.

Because eastern portions of the site would not be raised above flood elevations, less than significant impacts of the project on future flooding downstream[16] would be reduced. However, drainage patterns and the potential for flooding on the eastern portion of the site would be different that analyzed in the FEIR. Specifically, storm water flows could accumulate such that eastern portions of the site would be inundated in extreme flood events, particularly as climate change contributes to rising water levels.

Raising the level of access roads serving the western portion of the site and implementing Mitigation Measure HYDRO-7a (construction and operation of flood gates at the railroad right of way) would ensure that access to the site would be preserved in 100-year flood events. Compliance with Mitigation Measure HYDRO-7b would ensure that signs are installed in the railroad park area to inform park patrons of potential inundation during flood events. Implementation of HYDRO-6 would ensure compliance with FEMA flood hazard requirements and implementation of HYDRO-3 would ensure that storm water drainage systems are improved to appropriately convey and retain storm water in compliance with the County's road and street standards. These existing mitigation measures, already recommended to reduce impacts of the project, would ensure that impacts of the Developer's Revised Proposal related to flooding and storm water runoff are reduced to a less-than-significant level.

See Mitigation Monitoring and Reporting Program for text of mitigation measures.

Exhibit L.4 - Excerpt from Draft EIR: HYDROLOGY AND WATER QUALITY

7. Would the project place housing within a 100-year flood hazard area as mapped on a federal flood hazard delineation map?

The project is almost entirely within a 100-year flood hazard area as shown on the currently effective Flood Insurance Rate Maps 06055C0518E, 06055C0519E, and 06055C0610E. The Flood Hazard Analysis indicates that the project plans to raise the entire site, with exception of the wetlands and

[98] Barnes, K.K., Kolpin, D.W., Meyer, M.T., Thurman, E.M., Furlong, E.T., Zaugg, S.D., and Barber, L.B., 2002, Water-Quality Data for Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000: U.S. Geological Survey Open File Report 02-94.

Exhibit L.4 - Excerpt from Draft EIR: HYDROLOGY AND WATER QUALITY

the railroad, to a typical minimum elevation of 12 feet, with most residential finished floors at a minimum elevation of 15.5 feet.[99]

The proposed ground elevations at the site would make the raised portions, where all housing would be located, eligible for removal from the regulatory floodplain. The minimum finished floor elevations would be at least three feet above the 100-year flood elevations even with sea level rise taken into account. Key information from the Flood Hazard Analysis is summarized in Figure 4.10-7. As shown in the figure, river flooding is the controlling factor up to the point where sea level rise exceeds approximately 2.6 feet, at which point tidal flooding would become the controlling factor. The modeling presented in the FHA covers a range of estimated sea level rise up to 1.5 meters (4.9 feet) that is consistent with the range suggested for the year 2100 for use in Delta planning.[100,101,102]

The project would place housing within a 100-year flood hazard area as currently mapped on federal flood hazard delineation maps and as shown on the proposed LOMR prepared by Napa County. Therefore impacts would be *significan*t

Impact HYDRO-9: The project would place housing within a 100-year flood hazard area as currently mapped on federal flood hazard delineation maps.

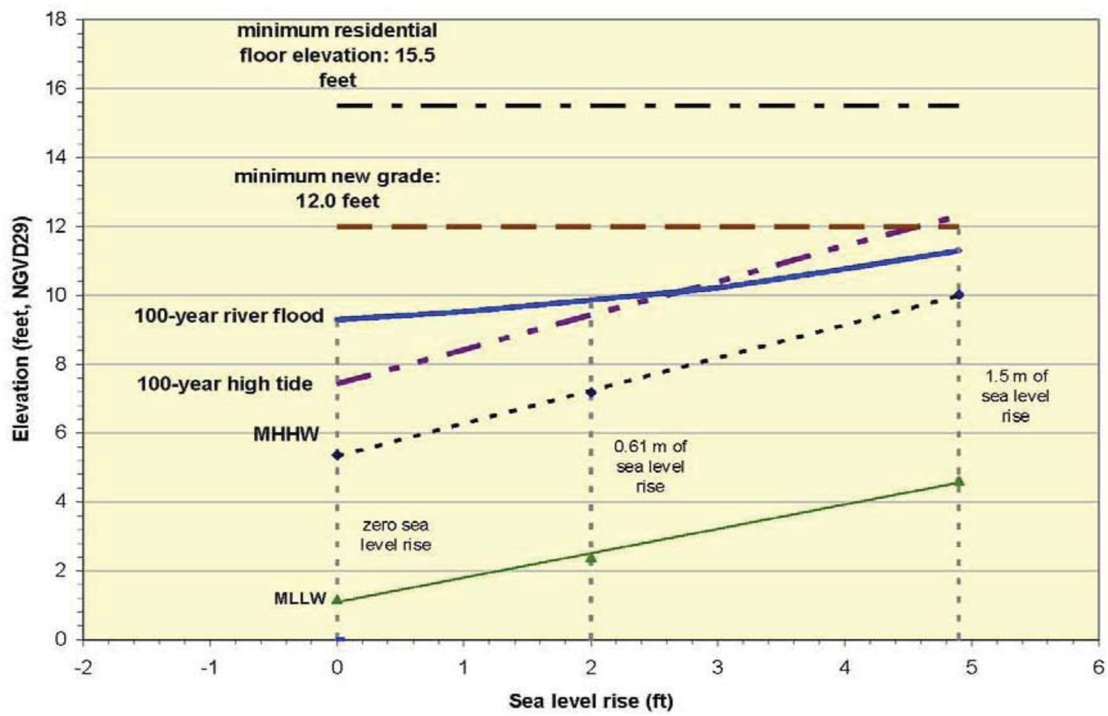
[99] Philip Williams & Associates, Ltd., January 2008, *Napa Pipe Site Redevelopment Project: Flood Hazard Analysis.*

[100] Delta Risk Management Strategy (Duffy), 2007. Technical Memorandum: Delta Risk Management Strategy Phase 1. Topical Area: Climate Change Draft 2.

[101] CALFED Independent Science Board (Mount), 2007. Sea Level Rise and Delta Planning. Letter to Michael Healey, Lead Scientist of the CALFED Bay-Delta Program, September 6, 2007.

[102] Delta Risk Management Strategy (URS Corporation, Jack R Benjamin & Associates, Inc.), 2008. Technical Memorandum: Delta Risk Management Strategy (DRMS) Phase 1. Topical Area: Climate Change Final.

Exhibit L.4 - Excerpt from Draft EIR: HYDROLOGY AND WATER QUALITY



Source: 1874_12-07_summary_with_MLLW.xls; data from Round 5 Q100 for multiple SLR rev .xls; Balance Hydrologics, Inc., 2009

FIGURE 4.10-7

FLOOD ELEVATIONS RELATIVE TO PROPOSED SITE GRADING

Exhibit L.4 - Excerpt from Draft EIR: HYDROLOGY AND WATER QUALITY

Mitigation Measure HYDRO-9: Prior to approval of the final grading plan, the project shall submit a request for a Conditional Letter of Map Revision (CLOMR) for review and action by FEMA and/or their designated representative in order to remove the elevated parcels from the SFHA.[103] With the approved CLOMR and placement of fill as described, the project shall submit a request for a Letter of Map Revision (LOMR).

Significance After Mitigation: With FEMA approval and issuance of the LOMR, all homes within the project would be out of the SFHA, and this impact would be reduced to a *less-than-significant* level.

8. Would the project place within a 100-year flood hazard area structures which would impede or redirect flood flows?

The Flood Hazard Analysis evaluated the currently effective flood hazard mapping (at the time of the report) and extended the analysis to include updated sea level rise for both the pre- and post-project conditions.[104] Further modeling was carried out, subsequent to publication of the FHA, to investigate the effect construction of the project would have on the 200-year flood event. The results of the analyses show minimal increases in flood elevations upstream of the project site due to the addition of fill at the site. The FHA results indicate an increase in 100-year flood elevation at Maxwell Bridge on Imola Avenue, two miles upstream of the site, of 0.6 inches under current sea level conditions and 0.7 inches with a 2-foot sea level rise attributable to placement of fill at the project site. This increase in water surface has been factored into the Napa River Flood Protection Project (NRFPP) as the USACE analyses, performed in support of that project, assumed no flood conveyance through the Napa Pipe site.[105,106]

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[103] A CLOMR is not strictly required, however it would be advisable. The LOMR or other separate determination by FEMA is necessary.

[104] Philip Williams & Associates, Ltd., 2008, *Napa Pipe Site Redevelopment Project: Flood Hazard Analysis,* January, 2008.

[105] Philip Williams & Associates, Ltd., 2008, *Napa Pipe Site Redevelopment Project: Flood Hazard Analysis,* January, 2008.

PWA FLOOD HAZARD ANALYSIS

Exhibit M.1 - Flood Hazard Analysis, prepared by Philip Williams & Associates, Ltd., dated May 28, 2009

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Napa Pipe Site Redevelopment Project:

Flood Hazard Analysis

Prepared for
Napa Redevelopment Partners

Prepared by
Philip Williams & Associates, Ltd.

May 28, 2009

PWA REF. # 1874 - T4

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Services provided pursuant to this Agreement are intended solely for the use and benefit of the Napa Redevelopment Partners.

No other person or entity shall be entitled to rely on the services, opinions, recommendations, plans or specifications provided pursuant to this agreement without the express written consent of Philip Williams & Associates, Ltd., 550 Kearny Street, Suite 900, San Francisco, CA 94108.

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05/28/09

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EXECUTIVE SUMMARY

Introduction

PWA conducted flood hazard studies for the proposed redevelopment of the Napa Pipe Site, south of the City of Napa, adjacent to the Napa River. Key results of those analyses with respect to the proposed site development are summarized below.

Project Description

As presently envisioned, the site will be redeveloped as a mixed-use project with 3200 units, neighborhood retail, restaurants, a condo hotel, offices, Research & Development/light industrial /warehousing uses and a park-like riverfront. The site would be raised to approximately 12' NGVD29.

Sources of flood hazard

There are two primary sources of flood hazards at this site: the flooding of the Napa River and extreme high tides from San Pablo Bay. Both factors will be aggravated with sea level rise. This analysis examines the effects on flooding for a range of potential sea level rise conditions.

Methodology

Two different computer models were used in conjunction to evaluate the two sources of flood hazard: HEC-RAS for river flood calculations and MIKE FLOOD for tidal conditions. Both models were based on existing hydraulic models that have been broadly accepted for the types of conditions analyzed.

For tidal conditions, we used the MIKE FLOOD model of the Napa-Sonoma system as previously developed for analysis and design of the Napa Salt Ponds project. This dynamic flow model allowed us to apply a time-variant estimated tidal signal at the mouth of the Napa River at San Pablo Bay to estimate the effects on stages upstream. We used it to evaluate typical tidal datums under a range of sea level rise conditions at the site, as well as the effect of a 100-year high tide at the site.

For river floods, we developed a steady-state HEC-RAS hydraulic model based on the HEC-2 model on which the currently effective FEMA (Federal Emergency Regulatory Agency) flood insurance rate maps are based. However, we used the more recent USACE 1998 General Design Memorandum 100-year peak river flow of 45,710 cubic feet per second (cfs), which is about one percent larger than the flow of 45,200 cfs used by FEMA.

In the process of this study, we found that the FEMA model uses an underestimated water level at Bull Island, about 2 miles downstream of the site, for its downstream boundary condition. The FEMA model appears to assume that the river elevation at Bull Island is only controlled by the tides in San Pablo Bay. In contrast, our computer simulation of conditions during a large river flood shows that elevated river flows significantly affect flow stage at this location. We therefore developed a new downstream boundary condition that was representative of river flood conditions. Using the MIKE FLOOD model, we analyzed a steady 100-year river flow against a typical high tide to estimate conditions at Bull Island. For present sea level conditions, our estimate of the water surface elevation at Bull Island under 100-year river flood conditions is 7.4 feet NGVD29, or about 3.2 feet higher than the value assumed in the effective FEMA model. As a result, our water elevation estimates at Napa Pipe as a result of that change alone are approximately 1 foot higher than the FEMA model.

To determine river flood levels at Napa Pipe, we used the HEC-RAS model, based on the current FEMA model, but modified to include the revised flow and downstream boundary as described above.

For both river and tidal flood conditions, we evaluated a range of sea level rise conditions ranging from 0.0 m to 1.5 m (0 ft to 4.9 ft), a range that easily encompasses most estimates of sea level rise from the present to about 100 years in the future.

Results

The results of our analyses of water surface elevations during flood events for different sea level conditions are shown in Figure 8. Also shown, for reference, are the proposed new site grade elevation and the design elevation of the lowest residential floor. The graph shows the expected Mean Higher High Water (MHHW) water levels at the site as a result of a range of sea level rises under typical high (2–year river flood) wet-weather flows, as well as water levels at an extreme (100-year) high tide and water levels during an extreme (100-year) river flood under the same range of sea level rise conditions. At the proposed grade, the site would be above the anticipated flood level even in the event of a dramatic rise in sea level in the future.

1. INTRODUCTION

The Napa Pipe Site is a 152-acre site just south of the City of Napa, CA that was formerly used for the manufacture of heavy steel products, including pipe (Figure 1). Multi-use redevelopment is presently being considered for the site, which is immediately adjacent to the Napa River. Philip Williams & Associates, Ltd. (PWA) was retained by Napa Redevelopment Partners for the purpose of assisting in flood hazard assessment and flood mitigation design for the project.

1.1 PROJECT DESCRIPTION

As presently envisioned, the site will be redeveloped as a mixed-use project with 3200 units, neighborhood retail, restaurants, a condo hotel, Research & Development/light industrial/warehousing uses and a park-like riverfront. The site would be raised to approximately 12 feet referenced to the National Geodetic Datum of 1929, or NGVD29[1].

1.2 EXISTING CONDITIONS

The current Napa County Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) indicates base (100-year) flood elevations in the Napa River adjacent to the project site of 7.5 – 8.9 feet NGVD29[2] (south to north) (Figure 1 and Figure 2). The 7.5-foot elevation defines the currently mapped estimated 100-year high tide, or the tide level estimated for this area with a 1-percent probability of being equaled or exceeded annually. This tidal stage is estimated based on an analysis of historic stage data conducted in the early 1980s (USACE 1984), and is currently being re-evaluated by FEMA, though it is unclear when the results of this ongoing analysis may be available for adoption into regulatory flood maps. Upstream of this tidal flooding boundary near the Highway 29 Bridge, the sloping 100-year peak water surface profile of the Napa River defines the flood elevations, rising from 7.5 feet to 8.9 feet at the upstream end of the site. The 8.9-foot elevation value reflects the expected effect of a 100-year peak flood flow on the Napa River, or the river flow estimated for this location with a 1-percent probability of being equaled or exceeded annually. The project site itself lies predominantly within the 100-year

[1] For the purposes of this document, all elevations provided will use an NGVD29 datum unless otherwise specified. Conversion to an NAVD88 datum at Mare Island requires the addition of approximately 2.66 feet, while conversion at the project site requires the addition of approximately 2.59 feet.

[2] The County and City of Napa Flood Insurance Studies (FISs) (1990; 2000) identify slightly different elevations for the 100-year high tide level from the Bay: 7.5 vs 7.4 feet (ft). The Napa County FIS dating from 1990 shows the former, more conservative value at Bull Island, extending up to the downstream end of the project site.

N

0 2000 4,000
feet

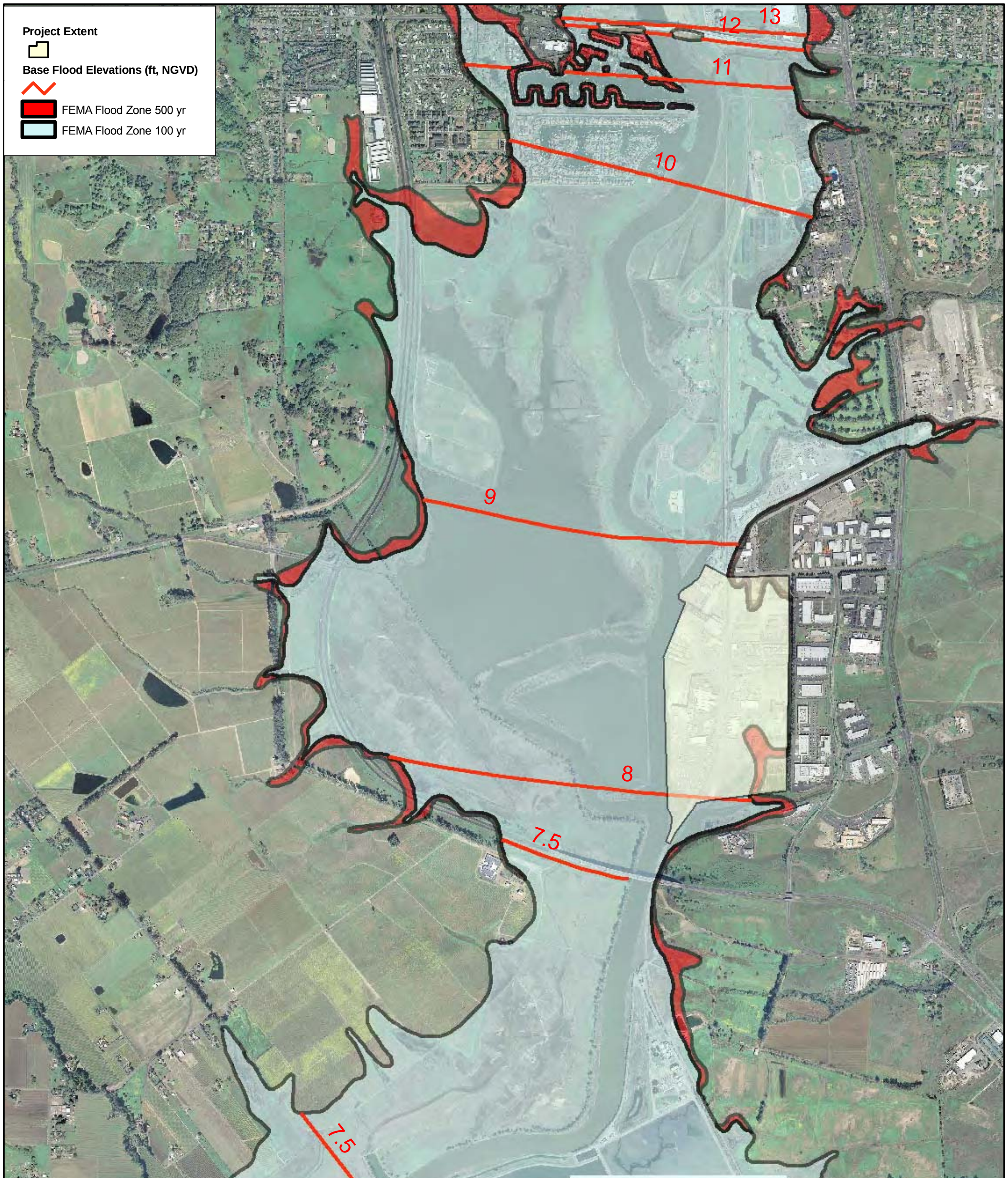
figure 1

Napa Pipe Site Redevelopment

Project Location Map

PWA

#1874 Report/figures



Source: FEMA (flood zones, BFEs), Napa County (aerial photos)

Note: City BFE lines were omitted for clarity.

N

0 1,500 3,000 6,000 Feet

figure 2

Napa Pipe Site Redevelopment

FEMA Flood Zones at Project Site

PWA Ref# - 1874

PWA

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floodplain but virtually entirely outside the designated floodway, the primary flow conveyance path identified by FEMA.

The present conditions along the river's edge at the project site are, from north to south: riprap along Asylum Harbor and a small portion of the Napa River; a concrete sea wall; four drydocks with steel gates; and a berm. These features presently limit the passage of floodwaters across the site in all but the largest flood events (e.g., a 100-year peak flow). On the opposite side of the river from the project site is Horseshoe Bend, where levees were breached to create a dedicated floodplain-wetland complex as part of the Napa River/Napa Creek Flood Protection Project, or NRFPP (USACE [US Army Corps of Engineers] 1998). About 1,200 feet downstream of the site is the Highway 29/12 Bridge; more than 14 miles downstream is the Carquinez Strait, at the mouth of the Napa River. The Maxwell Bridge (Imola Avenue) is 2 miles upstream of the site.

1.3 PURPOSE OF ANALYSIS

There are two primary sources of flood hazards at this site: the flooding of the Napa River from heavy rains upvalley, and extreme high tides from San Pablo Bay. Both factors will be aggravated with sea level rise.

The purpose of this flood hazard analysis is to inform and guide the site planning process as well as to inform the environmental review process by providing a technically-sound analysis of possible flood hazards. The analysis is geared both to the evaluation of flood hazards within the current regulatory context of FEMA's National Flood Insurance Program, in which both Napa County and the City of Napa participate, and also the potential future flood hazards at the project site due to rising sea level.

1.4 STRATEGY FOR DEALING WITH SEA LEVEL RISE

Many scientists are studying sea level rise, and although there is general consensus that levels are rising, it is still unclear how much and over what period of time this will occur. This uncertainty requires an approach that is flexible. We propose a strategy that uses fill to raise the site above reasonably anticipated flood levels, with, as back up, the possibility of future river wall/levee protection along the river.

To protect the site for a reasonably foreseeable sea level rise within a reasonably planning time horizon, our recommendation is to assume 2 feet of sea level rise, and fill the site at least to an elevation above the estimated water level for both a 100-year river flood event and a 100-year high tide.

1.5 REPORT ORGANIZATION

This document includes seven sections. Section 1 provides an introduction to the project and analysis presented herein. Section 2 provides a summary of our conclusions. Section 3 describes the data and information sources that were relied on. Section 4 describes the methodology used for the analysis. Section 5 is a presentation of the results. The remaining sections provide a list of staff who worked on the preparation of this analysis and report (Section 6) and references (Section 7).

2. CONCLUSIONS

As will be documented in the body of this report, we reached the following conclusions regarding the flood hazards on- and off-site for the proposed Napa Pipe Redevelopment Project:

1. Under existing conditions, FEMA regulatory (100-year) base flood elevations at the site range from 7.5 feet[3] to 8.9 feet.

2. The regulatory flood hazards downstream of the site are controlled by the influence of the estimated 100-year high tide. The regulatory flood hazards at the site itself are controlled by the influence of the estimated 100-year river flood in the Napa River channel.

3. Our analysis of the existing 100-year tidal conditions estimates a tidal flood elevation at the site of 7.4 feet, which is consistent with the FEMA estimate.

4. Our analysis of the existing 100-year river flow conditions estimates a 100-year river flood elevation at the site of 8.8 to 9.7 feet. This exceeds the FEMA estimates by approximately 1 foot.

5. Current scientific projections for sea level rise suggest potential increases on the order of 0.65 to 1.3 feet (0.2 to 0.41 meters) over the period from 1990 to 2050.

6. A sea level rise of 2 feet (0.61 meters) produces an estimated peak tide elevation during a 100-year tidal flood of 9.4 feet at the site.

7. A sea level rise of 2 feet produces an estimated 100-year river flood condition peak water surface elevation at the site of 9.5 to 10.1 feet.

8. The proposed grading plan for the site, which includes placement of fill to a typical minimum elevation of 12 feet, is expected to place the site above anticipated levels of both river and tidal flooding.

9. Structures at the site will be well above anticipated 100-year flood levels. Residential living floors are planned at elevation 15.5' or higher, giving a further large margin of safety.

10. The placement of fill at the project site does not cause an exceedance of the 100-year water surface elevation assumed by the US Army Corps of Engineers (USACE)

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[3] All elevations provided are referenced to the National Geodetic Vertical Datum of 1929, or NGVD29.

downstream of the Imola Avenue Bridge for the purpose of designing the Napa River Flood Protection Project (NRFPP). The Corps' analysis for the NRFPP assumed there would be no flood flow conveyance through the Napa Pipe site, and is therefore consistent with the concept of the placement of fill at the site.

11. The placement of fill at the project site is estimated to cause an increase of 0.6 inches downstream of Imola Avenue under current sea level conditions and 0.7 inches under sea level conditions with a 2-foot increase. As mentioned above, this increased water surface elevation has already been factored into the Napa River Flood Protection Project.

12. The placement of fill at the project site is estimated to cause a local increase of 1.9 inches at the site under both current sea level conditions and under sea level conditions with a 2-foot increase. As mentioned above, this increased water surface elevation has already been factored into the Napa River Flood Protection Project.

13. The placement of fill at the project site, resulting in some reduction in floodplain storage volume, is expected to have a negligible effect on 100-year peak flood flows downstream.

14. With the placement of fill as proposed, the site would be eligible for removal from the regulatory FEMA floodplain.

3. DATA AND INFORMATION SOURCES

For the purpose of assessing flood hazards at the site and the potential flood impacts that might be created by the project, it is necessary to evaluate two major sources of flooding: river-induced flooding from the Napa River and tidally-induced flooding from San Pablo Bay. We therefore reviewed the available data and information sources that could assist in our analysis of the flood hazards associated with each of these two sources.

3.1 EXISTING HYDROLOGIC AND HYDRAULIC ANALYSES

The most pertinent prior studies consist of those conducted by FEMA for the Flood Insurance Study (FIS), the US Army Corps of Engineers (USACE) for the Napa River Flood Protection Project (NRFPP). The current FIS for Napa County (1990) reports on both hydrologic and hydraulic analyses for the Napa River in the vicinity of the project site.

3.1.1 Hydrologic Analyses

Flood hazards on the Napa River have been studied extensively. Both the USACE and FEMA have published estimates for various recurrence interval peak discharges, including 100-year peak flows, in the Napa River in the vicinity of the project site.

The USACE hydrologic analysis was described in Appendix H of the Final Supplemental General Design Memorandum ([USACE] US Army Corps of Engineers 1998). The analysis used statistical analyses of historic flood flows together with a rainfall-runoff model to estimate peak flows for flood events in the Napa River basin at specific locations at a variety of recurrence intervals. This hydrologic information was then used to develop the NRFPP concept and design. The adopted design event for the NRFPP was the 100-year peak flow. The adopted flow rate estimates included an adjustment for expected probability, which factors in a modification to account for the length of the historic record relied on to develop the estimates.

The hydrologic analysis relied on by FEMA for the currently effective flood model is briefly described in the Napa County FIS (1990). The discharges reported for the 100-year peak flow in the Napa River in the vicinity of the project site from each of these sources are provided in Table 1.

Table 1. Estimates of Napa River 100-year peak flow at project site

	USACE GDM (1998)	FEMA FIS (2000)
Downstream of Imola Avenue (Maxwell Bridge)	45,710 cubic feet per second (cfs)	
Upstream of Bull Island		45,200 cubic feet per second (cfs)

The difference between these two values is very small: approximately 1 percent. For the purposes of this study, the larger value was used.

3.1.2 Existing Hydraulic Models

The most relevant existing hydraulic models for the Napa River adjacent to the flood site consist of the effective hydraulic model developed for FEMA's use in floodplain regulation, described in the FIS (the FEMA model), and the model developed for the Napa Salt Ponds Restoration Project, described in PWA (2002a) (the MIKE FLOOD model).

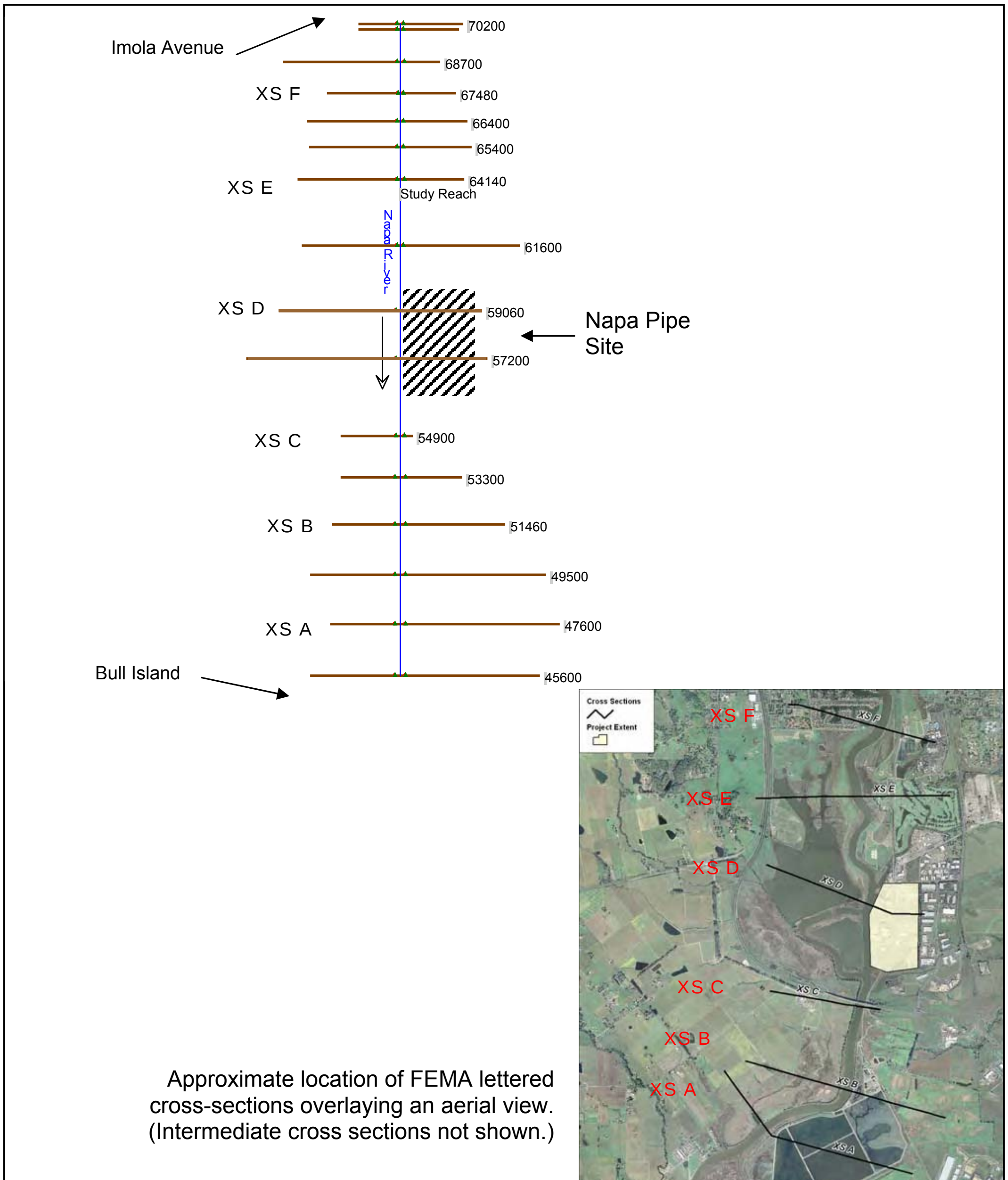
3.1.2.1 FEMA HEC-2 Model

The FEMA hydraulic model is referred to as the "effective" model because it is the source of information on the effective flood maps. The model was obtained from the FEMA archives as a digital file of a scanned hardcopy. A schematic of the FEMA model can be seen in **Figure 3**.

The particular utility of this model is its ability to provide a clear baseline for analysis of project flood hazard impacts using a model that is already in use by FEMA for regulatory purposes. While it is a fairly simple representation of flood flows, assuming a constant flow that moves in a single direction from one cross-section to the next, it is a standard method for flood hazard assessment and reasonable to apply in many riverine settings when the greatest concern – the water surface profile – is primarily influenced by one-dimensional forces and a peak flow condition is the dominant concern.

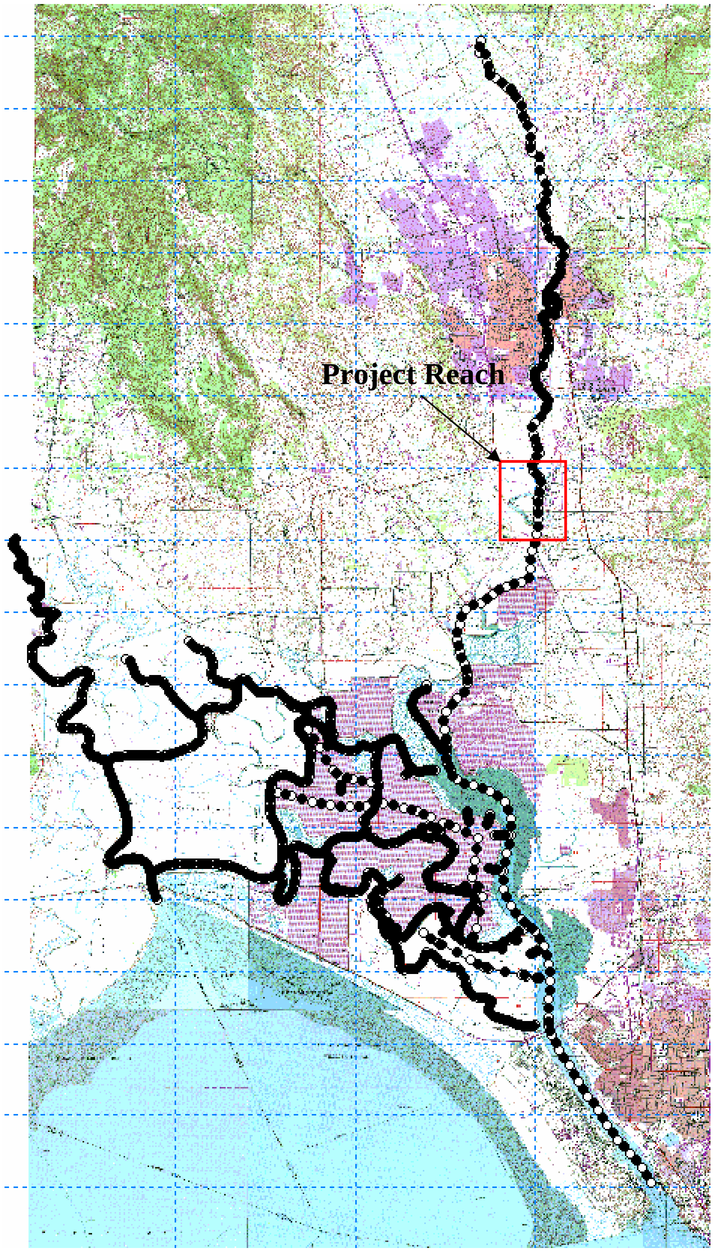
3.1.2.2 MIKE FLOOD Model

A linked one- and two-dimensional hydrodynamic model of the Napa River-Sonoma Creek complex was initially developed under a project to develop a restoration plan for the Napa-Sonoma Salt Ponds led by the following agencies: California Coastal Conservancy, the USACE, and the California Department of Fish and Game. DHI, the developer of the MIKE FLOOD software used for the model, was part of the PWA consultant team on the effort and led the development of the model. A schematic of the model network is shown in Figure 4.



Note: Model stationing is in feet from some unreferenced datum. *Source:* FEMA Flood Insurance Rate Maps and HEC-2 "With Levee" output file printout dated 7/25/86, Gill and Pulver Engineering.	*figure 3* *Napa Pipe Site Redevelopment* Schematic of the FEMA HEC-2 model PWA Ref# 1874 — PWA

\\orca\pwa\Projects\1874_NapaPipe\Deliverables\1874_flood_hazard_report_v4\figures\Fig3-Schematic of FEMA HEC-2 rev2.doc



Notes: Image shows one-dimensional network within the two-dimensional model of the Napa-Sonoma marsh complex. Closely-spaced nodes appear as a more continuous black line, while more widely-spaced nodes show as both black and white circles.

figure 4
Napa Pipe Site Redevelopment Project

Schematic of the MIKE FLOOD model

PWA Ref# 1874

PWA

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The development and calibration of the model were detailed in prior PWA reports (2002a) (2002b). Since that time, the model has continued to be modified and improved – most recently by the consultants working on final design of some of the marsh restoration projects.

While this model was developed to address much more complex hydrodynamics than peak flood flows in the Napa River, such as the time-variant interaction of flows in the broad marshplain between the Napa River and Sonoma Creek, its existence provides an opportunity to examine the effect of changes at San Pablo Bay on conditions in the lower Napa River. Because future sea level rise has the potential to affect the Napa Pipe site, the ability of this model to translate the effect of sea level changes in San Pablo Bay up the Napa River makes it of particular interest for an analysis of potential flood hazards associated with the project. Despite its focus on the Napa-Sonoma ponds, about 2.5 miles downstream of the furthest downstream point in the FEMA hydraulic model, the model extends up the Napa River as well. As a result, this model is able to simulate typical tidal and tidal flood conditions at the project site and downstream.

3.2 SEA LEVEL RISE

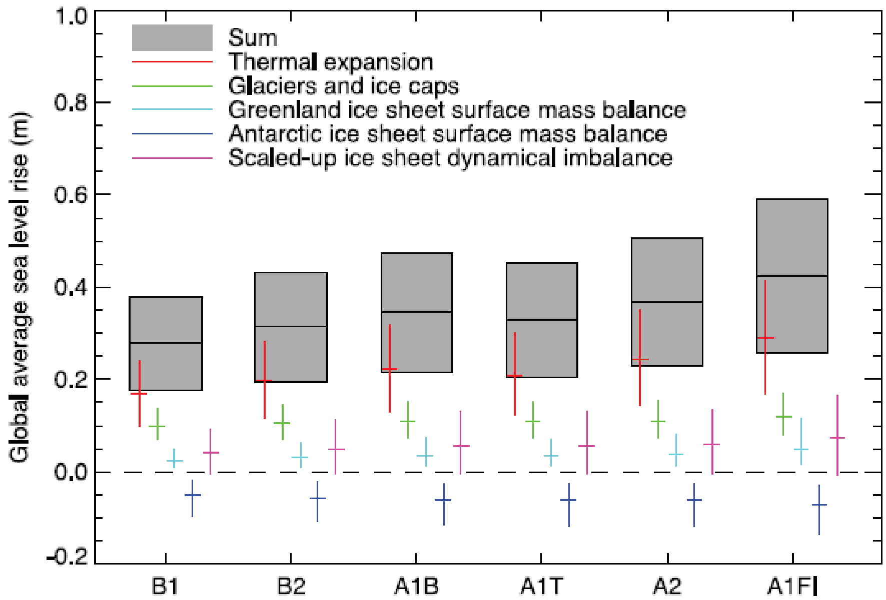
One of the challenging aspects of evaluating flood hazards in tidally-influenced landscapes and their environs is the issue of future sea level rise. In this section, we review some of the most recent recommendations for planning assumptions, all of which encompass broad ranges of possible sea level rise, to provide some context for the approach we take in this analysis.

3.2.1 Historic Rates of Global Sea-Level Rise

Based on tide measurements, the Intergovernmental Panel on Climate Change (IPCC) (2007) estimated a global average sea-level rise of 1.8 +/- 0.5 millimeters/year between 1961 and 2003, rising to 3.1 +/- 0.7 millimeters/year between 1993 and 2003. Prior to 1993, these estimates are based on relative sea-level measured at tide gauges corrected for land movements from either tectonics or glacial rebound. The estimate post-1993 is based on satellite altimetry.

3.2.2 Future Global Sea-Level Rise

Climate change simulations project global sea-level rise over the next century due to thermal expansion as the oceans warm and changes in ocean mass due to exchanges of water with glaciers, ice sheets, groundwater, or atmosphere. IPCC (2007) predicted a full range global average sea-level rise between 1990 and 2100 of 0.18-0.59 meters (0.6 feet - 1.9 feet) and a mid-range of 0.20–0.43 meters (0.7 feet - 1.4 feet).



Projections and uncertainties (5 to 95% ranges) of global average sea level rise and its components in 2090 to 2099 (relative to 1980 to 1999) for the six SRES marker scenarios. The projected sea level rise assumes that the part of the present-day ice sheet mass imbalance that is due to recent ice flow acceleration will persist unchanged. It does not include the contribution shown from scaled-up ice sheet discharge, which is an alternative possibility. It is also possible that the present imbalance might be transient, in which case the projected sea level rise is reduced by 0.02 m. It must be emphasized that we cannot assess the likelihood of any of these three alternatives, which are presented as illustrative. The state of understanding prevents a best estimate from being made.

This chapter should be cited as:

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao, 2007: Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Note:

Source: Figure 10.33 in Chapter 10 of IPCC (2007). See above for full citation.

figure 5
Napa Pipe Site Redevelopment

Estimated future (2090-2099) global sea level rise under multiple scenarios

PWA Ref# 1874

PWA

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More recent analysis by the Delta Risk Management Strategy (2007) argued that the modeled projections of IPCC (2007) are too low. This was based on a study by Stefan Rahmstorf (2006). Several reasons were provided:

- A linear extrapolation of historical rates would be higher than the low end of the IPCC (2007) projections. The IPCC (2007) historic rates of 1.8 millimeters/year and 3.1 millimeters/year would equate to 0.2 meters and 0.34 meters, respectively, of sea level rise over the period 1990-2100. The low end of the IPCC (2007) range (0.18 meters) would therefore require a deceleration of global sea-level rise. This is unlikely based on the likelihood of increased greenhouse gas emissions and the potential for accelerated melting of the Greenland ice sheet.
- The IPCC (2007) models under-predict historical sea-level rise. The sum of the modeled individual contributions to sea-level rise (thermal expansion, glaciers and ice caps, Greenland and Antarctic ice sheets) are lower than the observed sea level rise from tide gauges. It is possible that the models may also under-predict future sea-level rise.
- The IPCC (2007) projections exclude significant contributions from the potential accelerated future melting (by dynamical ice loss) of the Greenland ice sheet. Evidence suggests that significant melting is already underway (Cazenave 2006) and Overpeck et al. (2006) shows that sea levels during the last interglacial period were several meters higher than today due to extensive melting of land ice sheets.
- The use of empirical relationships (not models) projects higher rates of future sea-level rise. Rahmstorf (2006) used empirical relationships between observed rates of sea-level rise and temperature for the 20th century relative a pre-industrial threshold to predict full range increases of 0.5-1.4 meters during the 21st century. The relationship reflects only factors contributing to sea-level rise during 20th century, which means it may be an underestimate.

The projections of Rahmstorf (2006) were adopted by DRMS (2007) for the period 1990-2100, including estimates of 0.20 – 0.41 meters (0.65 – 1.3 feet) for the year 2050 and 0.20 – 1.4 meters (0.65 – 4.6 feet) for the year 2100. Given the nature of the focus of the DRMS work, the development of a strategy to minimize risks posed to panoply of critical state interests in the Sacramento-San Joaquin Delta at considerable expense, DRMS understandably chose an extremely risk-averse approach to planning. The CALFED Independent Science Board (2007) supported the conclusions of DRMS (2007) in a memorandum and recommended adoption of the empirical estimates (mid-range estimate of 0.7-1.0 meters and full range of 0.5-1.4 meters) for 2100 Delta planning.

Table 2. Estimates of future sea level rise for Year 2100 planning

	Full Range (feet)		**Mid-Range (feet)**	
	Low end	High end	Low end	High end
IPCC (2007)	0.6	1.9	0.7	1.4
DRMS/CALFED (2007)	1.6	4.6	2.3	3.3

Note: original values have been converted from meters to feet.

3.3 SITE PLANS

Currently the project site is at elevations of 5 to 10 feet. The proposed plan is to fill the site to a typical elevation of 12 feet[4]. Streets would be at this elevation, bordered by a 6-inch curb and sloped up to building pads. Finished residential floors would typically be constructed at about 3 feet above the curb, bringing the typical minimum finished floor elevation to 15.5 feet. An exception to the described pattern of fill would be the corridor encompassing the railroad tracks, which would remain at its current elevation and would therefore be lower than the rest of the site once the planned fill is in place.

With the planned level of fill, the Napa Pipe site development would lie at approximately 3.5 feet or more above the effective flood base flood elevation designated by FEMA, while finished floors would typically be elevated another 3.5 feet above that, or 7 feet above the currently effective base flood elevation. With the placement of fill as proposed, filled areas would be eligible for removal from the regulatory floodplain.

The whole site will be raised except an area around existing drydocks, a future park located in the floodway, the existing river bank, and existing and new wetlands at the south end of the site. These areas will remain in the floodplain and will periodically flood. The project is being designed so that no habitable structures will be located in these areas.

[4] Actual typical grade across the site would vary ± 0.5, with a decreasing elevation north to south, following the estimated slope of the river in flood.

4. METHODOLOGY

We used two hydraulic models to evaluate the two different flood hazard conditions, tidal and riverine. Our approach was to use the MIKE FLOOD model of the Napa-Sonoma Marsh complex to evaluate tidal flood hazards, as well as to estimate future river conditions at the downstream boundary of the FEMA hydraulic model given potential sea level rise. We then used the FEMA model to calculate flood hazard conditions in the river under both pre- and post-project conditions. The development and application of these models for these purposes is described in this Section.

4.1 MODEL DEVELOPMENT

Several modifications of the FEMA and MIKE FLOOD models were implemented for the purpose of this study. Some changes were made to the boundary conditions (e.g., inflow, downstream water surface elevation) to better reflect reality. These are described in this subsection.

4.1.1 MIKE FLOOD model

The MIKE FLOOD model of the Napa-Sonoma marsh complex links one- and two-dimensional models to represent channel flow and floodplain or marshplain flow, respectively. We elected to run the MIKE FLOOD model in a one-dimensional mode (the MIKE FLOOD submodel) because the channel flow dominates for the project site flood analysis and one-dimensional flow is far more time efficient. The model was then modified to reflect two different conditions: 1) typical tidal conditions and 2) 100-year tidal flood conditions.

4.1.1.1 General

In both tidal conditions, we input Napa River flows as a steady 2-year peak flow, a conservatively high “typical” winter high flow condition. This flow rate was derived from the USACE hydrology (1998). Other flow rates required at the model boundaries in the Napa watershed were also derived from the USACE hydrology (1998); the source hydrology for Sonoma Creek was derived from a hydrology study developed for that watershed ([PWA] Philip Williams & Associates 2004).

4.1.1.2 Typical tidal conditions

We used measured tidal stage data for July 2001 to represent typical tidal conditions at the downstream model boundary. The USGS collected this tidal stage data along the Napa River near Vallejo (referenced as Mare Island Causeway, or MIC, as described at URL:http://sfbay.wr.usgs.gov/sediment/cont_monitoring/index.html);. In a prior analysis, we identified the July 2001 record as a dataset that provides a signal that is very representative of typical tidal month conditions in this location: the tidal datums (e.g., mean higher high water or MHHW, mean lower low water or MLLW, etc.) produced by this signal are fairly similar to long-term values representative of this site. For the purpose of estimating "typical" tidal conditions, this dataset provides a reasonable approximation. The peak high tide during this sample month is approximately equal to what the USACE described as a 2-year high tide in the Carquinez Strait ([USACE] US Army Corps of Engineers 1998).

4.1.1.3 Tidal flood conditions

To estimate tidal flooding conditions, we estimated a storm surge increment using available estimates of peak 100-year tidal flood stage compared to the peak tide in the July 2001 tidal time series. We used estimates of peak 100-year tidal flood stage based on values reported in the *San Francisco Bay Tidal Stage vs. Frequency Study* ([USACE] US Army Corps of Engineers 1984) (Table 3).

Table 3. Existing estimates of 100-year tidal stage values

	Napa River at Mare Island	**Sonoma Creek Entrance**
	NGVD29, feet	**NGVD29, feet**
100-year	6.4	6.5

Notes: To convert NGVD29 to NAVD88, add 2.66 feet (0.812 meters) for Mare Island; 2.53 feet (0.771 meters) for Sonoma Creek.

PWA applied an incremental shift of 1.3 feet based on the difference between the values reported in Table 3 for the 100-year peak high tide and the July 2001 peak tide level (to represent the effect of storm surge for a 100-year tidal flood event, shifting the peak high tide upwards to equal the values shown in Table 3. The duration of the shift was limited to a 24-hour period bounding the peak tide level with an additional 6 hours either side for ramp up/down. The July 2001 data set includes a peak high tide of approximately 5.1 feet at the mouth of the Napa River.

4.1.2 FEMA model

The FEMA model was received as a digital image of a hardcopy printout of HEC-2 data and results. We converted it to a more modern version of the USACE hydraulic software (HEC-RAS), investigated the reasonableness of the downstream boundary condition and subsequently revised it, revised the hydrology to reflect the USACE GDM (1998) hydrology for 100-year peak river flow, and lastly created a version of the model including the proposed site fill.

4.1.2.1 Migration of the model to HEC-RAS

We reproduced the lowest reach of the model by hand-entering the input data. We then ran it in the USACE's HEC-2, the original software package used for simulation, and compared the results to confirm that we had accurately reproduced the original model. We then imported this model into HEC-RAS, the USACE's more modern version of the hydraulic model. Again, we reran the model to confirm that it was reasonably consistent with the original model.[5] Our results matched those reported for the FEMA HEC-2 within 0.03 feet (approximately 1/3 inch) or less at all cross sections.

4.2 MODEL APPLICATION STRATEGY

Our approach in applying these two models, as previously described, was to use the FEMA model to evaluate pre- and post-project conditions in a 100-year Napa River flood scenario and the MIKE FLOOD model, in a one-dimensional form, to evaluate 100-year tidal flood conditions. However, we also wished to include an analysis of the effects of potential sea level rise on both the tidal and riverine analyses.

4.2.1 Accounting for potential sea level rise

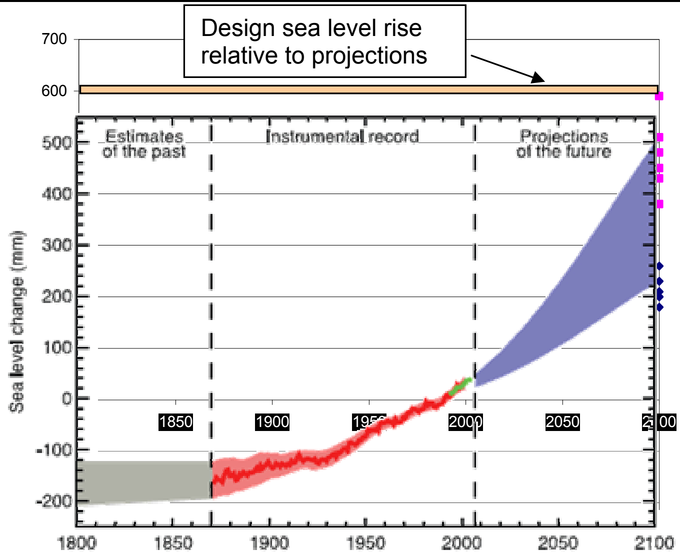
To account for potential sea level rise, we evaluated a range of values and selected a single value as a design assumption. Based on current thinking (see summary in Section 3.2), we determined to evaluate a range of values from 0.0 to 4.9 feet (1.5 meters) to cover a broad range of values.

However, we also elected to select a "design" value for potential sea level rise that represented conditions that were reasonably likely to occur only after reaching some planning horizon, with sufficient lead time to enable further actions if required. This design value established the standard against which current site plans were evaluated for adequacy.

We selected approximately 50 years as a reasonable planning horizon. As recently concluded by the CALFED ISB (2007) and described in Section 3.2.2, mid-range estimates for the year 2100 for sea level rise are on the order of 0.70 – 1.0 meter (2.3 – 3.3 feet). DRMS (2007) suggests a *high*-range value for the year 2050 of 0.41 meters (1.3 feet). Given that 2050 is estimated to be approximately 40 years out for the project, we have selected a design value of 2.0 feet (0.61m) as being a conservative value for sea level rise that is reasonably expected to not occur for at least 50 years into the life of the Napa Pipe Redevelopment project.

Given the lack of evidence of vertical regional tectonic movements or local subsidence in this area, we have assumed that sea level rise is equal to relative sea level rise at the mouth of the Napa River.

[5] Because computational methods are not identical between the two models, minor differences between the two sets of results is unavoidable.



Time series of global mean sea level (deviation from the 1980-1999 mean) in the past and as projected for the future. For the period before 1870, global measurements of sea level are not available. The grey shading shows the uncertainty in the estimated long-term rate of sea level change (Section 6.4.3). The red line is a reconstruction of global mean sea level from tide gauges (Section 5.5.2.1), and the red shading denotes the range of variations from a smooth curve. The green line shows global mean sea level observed from satellite altimetry. The blue shading represents the range of model projections for the SRES A1B scenario for the 21st century, relative to the 1980 to 1999 mean, and has been calculated independently from the observations. Beyond 2100, the projections are increasingly dependent on the emissions scenario (see Chapter 10 for a discussion of sea level rise projections for other scenarios considered in this report). Over many centuries or millennia, sea level could rise by several metres (Section 10.7.4).

When referencing the group of FAQs, please cite as:

IPCC, 2007: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

This Summary for Policymakers should be cited as:

IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Note: Original graph shows the projected future range for one of the scenarios evaluated by IPCC (2007). This graph overlays a graph showing the range projected for all six scenarios in ~2100 as described in Table SPM-3 of IPCC (2007).

Sources: Adapted from Figure 1, FAQ 5.1 in FAQs and Table SPM-3 in Summary for Policymakers of IPCC (2007). See above for full citations.

figure 6
Napa Pipe Site Redevelopment

Design vs. estimated global sea level rise: past, present, future

PWA Ref# 1874

PWA

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4.2.2 Tidal flood hazard analysis

For this analysis, we used an estimated 100-year storm surge increment (see Section 4.1.1.3 for the derivation) on top of a historical tidal signal typical for the mouth of the Napa River against a steady and conservatively high typical Napa River flow (2-year recurrence interval) to estimate resulting 100-year tidal flood hazards at the site. Modeling was completed using the MIKE FLOOD model.

To account for potential sea level rise, we simulated a range of anticipated sea level rise conditions affecting the tidal signal at the downstream boundary.

4.2.3 River flood hazard analysis

As in the original FEMA model, we expected our river flood analysis using the updated FEMA model to assume a steady 100-year Napa River flow against a steady MHHW condition at the downstream model boundary, at Bull Island. However, identification of the appropriate downstream model boundary condition uncovered a deficiency in the original FEMA model.

For river flood flow conditions, the downstream boundary of a one-dimensional hydraulic model typically has a significant bearing on what occurs upstream for some distance. Thus, we investigated the reasonableness of the assumed downstream boundary condition in the FEMA model, which was 4.2 feet for all flow rates included in the model. Based on the FIS (1990), this value was described as the estimated MHHW value for this location and about 1 foot higher than MHHW at the mouth of the Napa River. The use of MHHW as a tidal boundary condition is common practice in FEMA flood hazard analyses.

However, a test using the MIKE FLOOD model configuration with a 100-year Napa River flow against a typical tidal signal suggested that this assumed downstream boundary condition in the FEMA model grossly underestimated the water surface elevation that would exist in the channel under such circumstances. In essence, the effect of the high river flows caused stages in the channel at this location and downstream that were significantly elevated over typical conditions. Said another way, the FEMA model did not extend far enough downstream to assume that tidal conditions prevailed. A check of the estimated velocities in the channel provided in the FIS (1990) at the most downstream cross sections also suggested that the water surface at the downstream boundary of the model were inappropriately constrained: they were much higher than the velocities estimated at cross sections upstream.

For the purposes of this analysis, therefore, we used the MIKE FLOOD model to generate estimates of water surface elevations at the downstream boundary of the updated FEMA model. The runs assumed a steady 100-year river flood condition against a typical tidal signal. For present conditions of sea level, our estimate of MHHW at this location was 7.38 feet, which is about 3.2 feet higher than originally assumed in the FEMA model. We believe this estimate provides a more appropriate boundary condition for analysis of 100-year river flood conditions at the site.[6]

To account for potential sea level rise, we generated a range of downstream boundary conditions for the FEMA model based on a range of anticipated sea level rise conditions and applied the FEMA model to each sea level rise condition, with- and without-project fill placement. We identified the 2-foot sea level rise simulation as our design, or assumed, future sea level rise condition.

[6] The PWA simulations estimate 100-year water levels at the site at 8.8 to 9.7 feet, approximately 1 foot higher than the existing FEMA analysis. Photographic and anecdotal evidence of flooding at the site in 1986 and 2005, which were on the order of a 50- to 100-year and 25- to 50-year flood events, respectively, produced water levels on the site of approximately 7.8 and 7.2 feet respectively. While stages may have been higher at the river than on the project site during these events, this information suggests that our 100-year stage estimates may be conservative. Actual 100-year flood elevations may be closer to the 8 - 9 foot elevation range estimated by FEMA, rather then our 9 - 10 foot elevation estimate. Given the lack of detailed calibration data, however, we believe our estimates are appropriate to use for the current impact analysis and design purpose. We recommend erring on the conservative side when uncertainties exist.

5. RESULTS

The results of our flood hazard analysis, which were also summarized in Section 2, are presented below.

5.1 TIDAL FLOOD ANALYSIS

The results of our tidal flood analysis show an existing condition estimated 100-year tidal flood at the project site to have an elevation of 7.4 feet, consistent with the FEMA FIS for the City of Napa (2000). Under future (design) conditions of sea level rise, the 100-year high tide is estimated to have an elevation of 9.4 feet. These results are appropriate estimates for both with- and without-project conditions, as a tidal flood stage is not expected to be affected by the placement of fill at the site.

5.2 RIVER FLOOD ANALYSIS

Our riverine flood analysis estimates a without-project 100-year river flood elevation of 8.8 to 9.7 feet across the site under current sea level conditions. This is approximately 1 foot higher than the elevations shown on current FEMA flood maps. Under future (design) conditions of sea level rise, the 100-year river flood is estimated to have a without-project elevation of 9.5 to 10.1 feet, an increase of approximately 0.4 to 0.7 feet due to assumed sea level rise.

The same analysis was completed for with-project conditions, which were approximated as assuming placement of fill to a consistent 12 feet in elevation across the project site. Under these conditions at current sea levels, we estimated a with-project 100-year river flood elevation of 8.8 to 9.8 feet across the site under current sea level conditions. Under future (design) conditions of sea level rise, the 100-year river flood is estimated to have a with-project elevation of 9.5 to 10.3 feet, an increase of approximately 0.7 to 0.4 feet, respectively, due to sea level rise. See Figure 7 for a graphical depiction of the water surface profiles across the site generated by our analysis and described here.

A comparison of results shows that the placement of fill for the project at the anticipated levels is expected to increase water surface elevations by a maximum of 0.16 feet (1.9 in) adjacent to the site and less upstream of the site under current or future sea level conditions. No effect is expected downstream of the project site. The effect of the fill diminishes significantly by the time the effect has translated upstream to the Imola Avenue Bridge, dropping to an increase of only 0.05 feet (0.6 inches) for a water surface elevation of 12.40 feet under current sea level conditions. Under future conditions of sea level rise, the increase is only 0.06 feet (0.7 inches) feet for a total elevation of 12.56 feet. Based on the USACE design water surface profile (Don Twiss, USACE, pers. comm. April 1, 2005), the USACE assumed a water surface elevation for the NRFPP downstream of Imola Avenue of 12.77 feet, a value that is greater than the projected water surface elevation estimated by our analysis for either the with-project current or future conditions of sea level rise.

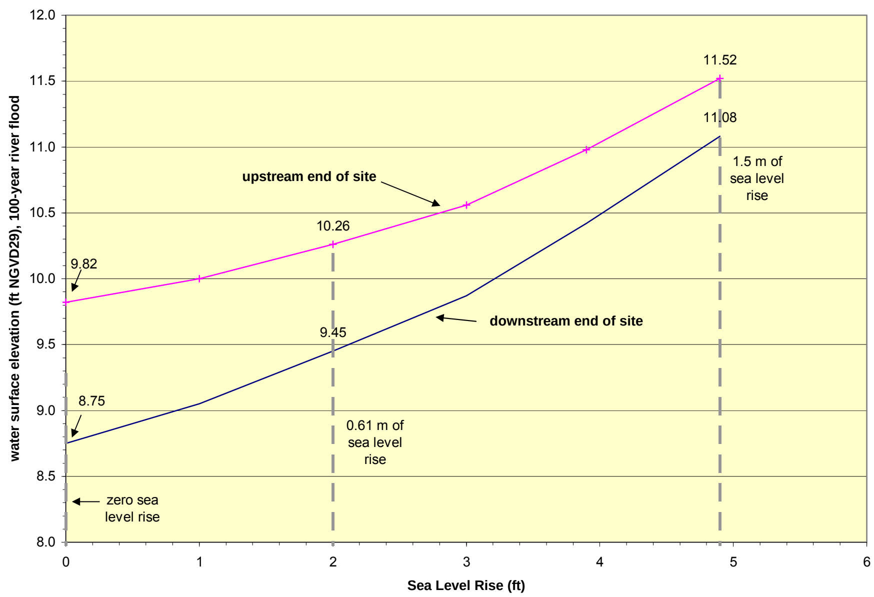
Thus, the placement of fill at the project site does not cause an exceedance of the 100-year water surface elevation assumed by the US Army Corps of Engineers (USACE) downstream of the Imola Avenue Bridge for the purpose of designing the Napa River Flood Protection Project (NRFPP). Based on the description in the GDM (1998), the USACE analysis for the NRFPP assumed there would be no flood flow conveyance through the Napa Pipe site, and is therefore consistent with the concept of the placement of fill at the site.

To test the effect of the proposed fill on flood storage and resultant downstream flows, we also created an unsteady version of the HEC-RAS model. At the upstream end, we used a 100-year Napa River hydrograph and at the downstream end a rating curve to estimate the relationship between flow and stage. The stage-discharge curve was constructed as follows. A steady-state HEC-RAS model with a normal depth assumption (friction slope of 0.000062; zero sea level rise assumption) was used in combination with a 10-year flow rate to provide a better estimate of stage at lower flows. The upper end of the stage discharge curve was interpolated between this point and the 7.4 foot stage estimate for a 100-year flow developed with the MIKE-FLOOD unsteady model and used in this study for our river flood hazard analysis under a zero sea level rise assumption.

The results of this analysis showed that the difference in maximum flow rates for pre- and post-project conditions at the downstream limit of the HEC-RAS model, Bull Island, was less than 100 cfs (out of 45,710 cfs). This indicates that the effect of the lost floodplain storage on downstream peak flows is quite small. Our rating curve suggests a resultant stage difference at this location of less than 1 inch. When tested with 4.9 feet (1.5m) of sea level rise, the estimated effects are very similar: just over 100 cfs increase in peak flow at Bull Island and a resultant stage difference at this location that remains less than 1 inch. Therefore, the project effect on 100-year peak flood flows as a result of lost floodplain storage volume is expected to be negligible.

5.3 EFFECTS OF POTENTIAL SEA LEVEL RISE

Rising sea level at San Pablo Bay will increase water levels past the project site (Figure 8). As sea level increases, the effect of the increase on the stage of the 100-year high tide at the site grows at nearly the same rate: 1 foot of sea level rise translates to nearly a 1 foot increase in the stage of the 100-year high tide. The magnitude of the effect of sea level rise on the 100-year peak river flow water surface elevation at the site also grows as sea level rise increases, but the effect is muted, especially at lower levels of sea level rise. The increase in peak 100-year river flood elevation at the site remains at a rate of less than 0.5 foot increase per 1.0 foot of sea level rise increase even at higher levels of sea level rise.



Source: Round 5 Q100 for multiple SLRs rev.xls

figure 7
Napa Pipe Site Redevelopment Project

With-project 100-year river flood elevations relative to potential sea level rise

PWA Ref# 1874 – T4

PWA

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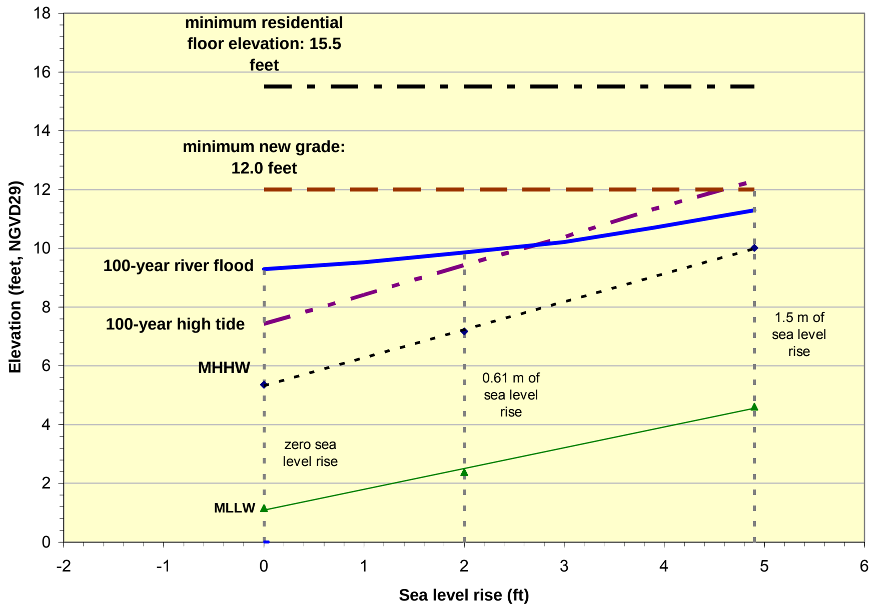
5.4 ASSESSMENT OF SITE GRADING PLAN RELATIVE TO FLOOD HAZARDS

The current site grading concept, as described in Section 3.3, calls for fill at the site to a minimum elevation of 12 feet. As shown by Figure 8, at the proposed grade, the site would be above the anticipated flood level even in the event of a dramatic rise in sea level in the future. At the design sea level rise, river flood levels would remain most constraining. Under that future condition, roads would be still be more than 2 feet above the expected 100-year flood level and future finished floors would be on the order of 5.5 feet above the expected 100-year flood level. Since streets would not be affected, ingress and egress from the site would not be affected by flood hazards at the 100-year or 1-percent probability level.

With the placement of fill as proposed, all filled portions of the site would be eligible for removal from the regulatory FEMA floodplain.



Source: 1874_12-07_summary_with_MLLW.xls; data from Round 5 Q100 for multiple SLRs rev.xls	*figure 8* *Napa Pipe Site Redevelopment Project*
	With-project typical site 100-year flood elevations relative to proposed grading
	PWA Ref# 1874 – T4 PWA

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6. LIST OF PREPARERS

This report was prepared by the following PWA staff:

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7. REFERENCES

[CALFED ISB] CALFED Independent Science Board (Mount) (2007). Sea-Level rise and Delta planning. Letter to Michael Healey, Lead Scientist of the CALFED Bay-Delta Program (September 6, 2007).

Cazenave, A. (2006). "How fast are the ice sheets melting?" Science **314**: 1250-1252.

[DRMS] Delta Risk Management Strategy (Duffy) (2007). Technical Memorandum: Delta Risk Management Strategy (DRMS) Phase 1. Topical Area: Climate Change Draft 2.

[FEMA] Federal Emergency Management Agency (1990). Flood Insurance Study: Unincorporated Napa County, CA.

[FEMA] Federal Emergency Management Agency (2000). Flood Insurance Study: City of Napa, CA, Napa County.

[IPCC] Intergovernmental Panel on Climate Change (Solomon et al.) (2007). Technical Summary. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA., Cambridge University Press.

Overpeck, J. T., Otto-Bleisner, B.L., Miller, G.H., Muhs, D.R., Alley, R.B., Kiehl, J.T. (2006). "Paleoclimatic evidence for future ice-sheet instability and rapid sea-level rise." Science **311**: 1747-1750.

[PWA] Philip Williams & Associates, L. (2004). Sonoma Creek & Tributaries Basin Hydrologic Investigation. Project #1411.21.

[PWA] Philip Williams & Associates Ltd. (2002a). Napa River salt marsh restoration: habitat restoration preliminary design, hydrodynamic modeling analyses of existing conditions, phase 1 - in support of the feasibility study. Prepared for the California State Coastal Conservancy. PWA report #1174-8. In: California State Coastal Conservancy, US Army Corps of Engineers, and California Department of Fish and Game. Napa River Salt Marsh Restoration Project Feasibility Report. Appendix D.

[PWA] Philip Williams & Associates Ltd. (2002b). Napa River salt marsh restoration: habitat restoration preliminary design, phase 2, stage 1 - salinity reduction, habitat evolution, sediment budget. Prepared for the California State Coastal Conservancy. PWA report #1545/1546 In: California State Coastal Conservancy, US Army Corps of Engineers, and California Department of Fish and Game. Napa River Salt Marsh Restoration Project Feasibility Report. Appendix D.

Rahmstorf, S. (2006). "A semi-empirical approach to projecting future sea-level rise." Science **315**: 368-370.

[USACE] US Army Corps of Engineers (1984). San Francisco Bay Tidal Stage vs. Frequency Study. US Army Corps of Engineers, San Francisco District.

[USACE] US Army Corps of Engineers (1998). Napa River/Napa Creek Flood Protection Project: Final Supplemental General Design Memorandum. Napa, CA, Napa County Flood Control and Water Conservation District.

USACE [US Army Corps of Engineers] (1998). Napa River/Napa Creek Flood Protection Project: Final Supplemental General Design Memorandum. Napa, CA, Napa County Flood Control and Water Conservation District.

GEOTECHNICAL REPORT

Exhibit N.1 - Geotechnical Report, prepared by Treadwell & Rollo, dated January 23, 2007

Treadwell&Rollo

23 January 2007
Project 4467.01

Mr. Caspar Mol
Napa Redevelopment Partners
The Hearst Building
5 Third Street, Suite 1014
San Francisco, California 94103

Subject: Geotechnical Feasibility Study
Napa Pipe Facility Site
1025 Kaiser Road
Napa, California

Dear Mr. Mol:

This letter report presents the results of our geotechnical feasibility investigation at the Napa Pipe facility site at 1025 Kaiser Road in Napa, California.

1.0 PROJECT BACKGROUND

The site encompasses approximately 152 acres and is bound by the Napa River to the west, Kaiser Road to the north, Syar Industrial Way to the east, and open fields to the south (see Figure 1). It is approximately rectangular in shape measuring about 3,800 feet in the north-south direction and 1,800 feet in the east-west direction. Several industrial buildings, warehouses, various small structures, concrete and asphalt pavements and wetlands occupy the site. The site is generally flat with elevations ranging from approximately 6 to 9 feet[1], with the exception of the wetland at the southwest corner of the site, where the general elevation ranges from 1 to 2 feet. An existing Southern Pacific Railroad track runs north-south within the site and divides the site approximately in half (see Figure 2).

We understand the proposed development will include apartment, condominium, and senior housing facilities as well as offices, hotel, R&D Space and Light industrial. The proposed structures are three to four stories high, but may be up to seven stories tall. Furthermore, plans are to also construct some up to three-story tilt-up structures and place up to four feet of fill to raise the general grade level of the site to approximately elevations of 9 to 10 feet. A vehicular bridge is also proposed at the southern property line.

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[1] All elevations reference NGVD Mean Sea Level Datum of 1929.

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2.0 SCOPE OF SERVICES

The objectives of our investigation were to explore and evaluate subsurface conditions at the site and to provide a geotechnical feasibility level study for the general project. We evaluated the subsurface conditions by reviewing subsurface information in the vicinity, drilling test borings, and performing laboratory tests on samples recovered from the borings.

Engineering studies were performed using the soil and groundwater conditions defined by the borings and engineering parameters developed from the laboratory testing program. On the basis of field and laboratory tests and our engineering analyses, we developed conclusions and preliminary recommendations regarding:

- appropriate foundation type(s) for proposed buildings
- estimates of building settlements, including total and differential settlements
- site seismicity and seismic hazards, including location of known faults and liquefaction potential
- site grading, including criteria for fill quality and compaction
- subgrade preparation for slab-on-grade floors, pavements, and flatwork areas
- 2001 California Building Code soil profile type and near-source factors
- construction considerations.

In addition to the feasibility study for the project site in general, we developed preliminary foundation design recommendations for the proposed bridge. Based on discussions with Riechers Spence and Associates (structural engineers), we developed preliminary conclusions and recommendations for the bridge regarding the following:

- seismic design recommendations, including appropriate Caltrans Seismic Design Criteria (SDC) ARS curve and peak rock acceleration,
- modifications to the Caltrans ARS curves due to near-fault and deep soil profile effects,
- pile foundation type recommendations, including pile capacity, pile length, and construction considerations,
- site seismicity and seismic hazards, if any, including liquefaction potential.

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3.0 FIELD INVESTIGATION

We reviewed the results of previous investigations performed in the vicinity of the site and explored subsurface conditions at the site by drilling six test borings, designated as B-1 through B-6. The approximate locations of the borings are shown on Figure 2.

Prior to performing our field investigation, we:

- obtained a drilling permit from the Napa County;
- notified Underground Services Alert; and
- cleared the boring locations of underground utilities using an independent utility locating contractor.

3.1 Soil Borings

From 23 through 25 August 2006, six test borings, designated B-1 through B-6, were drilled by Pitcher Drilling Company using a truck-mounted, rotary-wash drill rig. The test borings were drilled to depths of approximately 49.5 to 100 feet below the existing ground surface, except for boring B-2, which was terminated at 13 feet. While drilling boring B-2, hydrocarbon odor was detected at the groundwater level. At the direction of PES Enviromental, the project environmental consultants, the decision was made to terminate the boring B-2 at a depth of 13 feet.

Our field engineers logged the borings and obtained samples of the material encountered for visual classification and laboratory testing. Upon completion, the borings were backfilled with grout consisting of cement, bentonite and water, in accordance with Napa County requirements.

The logs of the borings are presented on Figures A-1 through A-6 in Appendix A. The soil is classified in accordance with the chart shown on Figures A-7.

Soil samples were obtained using three different types of samplers: two split-barrel samplers and one thin-walled sampler. The sampler types are as follows:

- Sprague and Henwood (S&H) split-barrel sampler with a 3.0-inch outside diameter and 2.5-inch-inside diameter, lined with brass tubes with an inside diameter of 2.43 inches
- Standard Penetration Test (SPT) sampler with a 2.0-inch-outside and 1.5-inch-inside diameter, without liners
- Shelby tubes with a 3.0-inch outside diameter and 2.875-inch inside diameter.

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The sampler types were chosen on the basis of soil type and desired sample quality for laboratory testing. In general, the S&H sampler was used to obtain samples in medium stiff to very stiff cohesive soil and the SPT sampler was used to evaluate the relative density of sandy soil. The Shelby tube piston sampler was used to obtain relatively undisturbed samples of the soft to medium stiff cohesive soil.

The S&H and SPT samplers were driven with a 140-pound automatic hammer falling about 30 inches. For both the SPT and S&H sampler, the blow counts required to drive the sampler the final 12 inches of an 18-inch drive were corrected with factors of 1.1 and 0.7, respectively, to approximate SPT N-blow counts and are shown on the boring logs. Hydraulic pressure was also used to advance the 36-inch-long Shelby tubes into the soil and the pressure required is shown on the logs, measured in pounds per square inch (psi).

A bulk sample was collected near boring B-3 from the cuttings of the auger from the upper 1.5 to 3.5 feet.

3.2 Laboratory Testing

All samples recovered from the field exploration program were examined for soil classification, and selected samples were tested in the laboratory.

Our laboratory testing program was designed to correlate soil properties and to evaluate engineering properties of the soil at the site. Samples were tested to measure moisture content, dry density, percent fines (material passing the No. 200 sieve), strength, consolidation parameters, Atterberg limits and R-value. The test results are presented on the boring logs and in Appendix B.

4.0 SITE AND SUBSURFACE CONDITIONS

The site is currently occupied by several industrial buildings, warehouses, various small structures, concrete and asphalt pavements, and a wetland. A Pacific Gas & Electric overhead tower line is located along the southern boundary of the site. An existing Southern Pacific Railroad track runs north-south within the site and divides the site approximately in half. The Napa River currently runs along the western property line. We understand that most of the site is within a designated flood zone.

The site is generally flat with elevations ranging from approximately 6 to 9 feet, with the exception of the wetland at the southwest corner of the site, where the general elevation ranges from 1 to 2 feet.

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Subsurface information from this investigation indicates that at B-2, B-3, B-4 and B-6 the ground surface is covered with pavement sections that consists of approximately 9 to 18 inches thick aggregate base (AB) overlain by 2 to 6 inches thick asphalt concrete (AC).

Our test borings indicate the site is blanketed by 1.5 to 8 feet of fill. The fill may be thicker at boring B-2, which was terminated before the bottom of fill could be verified. The fill generally consists of medium stiff to very stiff sandy clay and gravelly clay and medium dense to very dense sand, clayey sand and clayey gravel. Atterberg limits tests on the fill indicate the near-surface clays are moderately to highly expansive[2].

In borings B-3, B-4 and B-6, the fill is underlain by very soft to stiff clay with organics that varies in thickness from 2.5 to 17 feet. This strata appears to be a marine deposit. Where tested, the marine deposit appears to be normally to slightly overconsolidated[3]. The results of laboratory tests indicate that the undrained shear strengths of the marine deposit ranges from 200 to 1,370 pound per square foot (psf). Boring B-1 and B-5 did not encounter the marine deposit and B-2 was not advanced deep enough to determine if the marine deposit is present at that location.

The fill and marine deposit (where encountered) are generally underlain by a deep alluvium deposit, which consists of layers of medium dense to very dense sand and gravel with variable clay and silt content and stiff to hard clay and silt layers to the maximum explored depth. The results of laboratory tests indicate that the undrained shear strengths of the alluvium ranges from 3,020 to 3,080 psf. The clay layers in the alluvium are overconsolidated and exhibit low compressibility under moderate loads.

On the basis of a review of the geologic maps and well logs prepared by the California Department of Water Resources[4], the depth to bedrock in the area ranges from 275 to 455 feet below the ground surface.

The subsurface conditions are presented on an idealized subsurface profile on Figure 3. The location of the profile is shown on Figure 2.

Groundwater was measured in all the borings, except boring B-4, prior to the start of rotary wash. Measured groundwater ranged from 6 feet below the ground surface (bgs) in B-6 (Elevation 2.8 feet) to 9 feet bgs in B-5 (Elevation -2 feet).

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2 Highly expansive soil undergoes relatively large volume changes with changes in moisture content.

3 A normally consolidated clay has completed consolidation under the existing pressure; and an overconsolidated clay has experienced a pressure greater than its current overburden pressure.

4 Kunkel, F. and J.E. Upson (1960). "Geology and Ground Water in Napa and Sonoma Valleys, Napa and Sonoma Counties, California, Geology Survey Water-Supply Paper 1495.

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5.0 REGIONAL SEISMICITY AND FAULTING

The major active faults in the area are the West Napa, Hayward, San Andreas, San Gregorio, and Calaveras Faults. These and other faults of the region are shown on Figure 4. For each of the active faults within 50 km, the distance from the site and estimated mean characteristic Moment magnitude[5] [Working Group on California Earthquake Probabilities (WGCEP)[6] (2003) and Cao et al. (2003)][7] are summarized in Table 1.

TABLE 1
Regional Faults and Seismicity

Fault Segment	Approx. Distance from fault (km)	Direction from Site	Mean Characteristic Moment Magnitude
West Napa	1.4	West	6.50
Concord/Green Valley	12	East	6.71
Rodgers Creek	21	West	6.98
Total Hayward-Rodgers Creek	21	West	7.26
North Hayward	23	Southwest	6.49
Total Hayward	23	Southwest	6.91
Hunting Creek-Berryessa	23	Northeast	6.90
Great Valley 4	34	East	6.60
Great Valley 5	34	East	6.50
Mt Diablo – MTD	47	Southeast	6.65
Great Valley 6	47	East	6.70
South Hayward	48	South	6.67
San Andreas – 1906 Rupture	50	Southwest	7.90
San Andreas – North Coast South	50	Southwest	7.45

Figure 4 also shows the earthquake epicenters for events with magnitude greater than 5.0 from January 1800 through December 2000. Since 1800, four major earthquakes have been recorded on the San Andreas Fault. In 1836 an earthquake with an estimated maximum intensity of VII on the Modified Mercalli (MM) scale (Figure 5) occurred east of Monterey Bay on the

5 Moment magnitude is an energy-based scale and provides a physically meaningful measure of the size of a faulting event. Moment magnitude is directly related to average slip and fault rupture area.

6 Working Group on California Earthquake Probabilities (WGCEP) (2003). "Earthquake probabilities in the San Francisco Bay region: 2002 to 2031." Open File Report 03-214.

7 Cao, T., Bryant, W. A., Rowshandel, B., Branum D. and Wills, C. J. (2003). "The Revised 2002 California Probabilistic Seismic Hazard Maps."

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San Andreas Fault (Toppozada and Borchardt 1998)[8]. The estimated Moment magnitude, M_w, for this earthquake is about 6.25. In 1838, an earthquake occurred with an estimated intensity of about VIII-IX (MM), corresponding to a M_w of about 7.5. The San Francisco Earthquake of 1906 caused the most significant damage in the history of the Bay Area in terms of loss of lives and property damage. This earthquake created a surface rupture along the San Andreas Fault from Shelter Cove to San Juan Bautista approximately 470 kilometers in length. It had a maximum intensity of XI (MM), a M_w of about 7.9, and was felt 560 kilometers away in Oregon, Nevada, and Los Angeles.

The most recent earthquake to affect the Napa area was a M_W of 5 earthquake on the Napa fault that occurred on 3 September 2000.

In 1868 an earthquake with an estimated maximum intensity of X on the MM scale occurred on the southern segment (between San Leandro and Fremont) of the Hayward Fault. The estimated M_w for the earthquake is 7.0. In 1861, an earthquake of unknown magnitude (probably a M_w of about 6.5) was reported on the Calaveras Fault. The most recent significant earthquake on this fault was the 1984 Morgan Hill earthquake ($M_w = 6.2$).

In 2002 the Working Group on California Earthquake Probabilities (WGCEP 2003) at the U.S. Geologic Survey (USGS) predicted a 62 percent probability of a magnitude 6.7 or greater earthquake occurring in the San Francisco Bay Area by the year 2031. More specific estimates of the probabilities for different faults in the Bay Area are presented in Table 2.

TABLE 2
WGCEP (2003) Estimates of 30-Year Probability (2002 to 2031) of a Magnitude 6.7 or Greater Earthquake

Fault	Probability (percent)
Hayward-Rodgers Creek	27
San Andreas	21
Calaveras	11
San Gregorio	10
Concord-Green Valley	4
Greenville	3

[8] Toppozada, T. R. and Borchardt G. (1998). "Re-Evaluation of the 1836 "Hayward Fault" and the 1838 San Andreas Fault earthquakes." *Bulletin of Seismological Society of America*, 88(1), 140-159.

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6.0 DISCUSSION AND PRELIMINARY RECOMMENDATIONS

The primary geotechnical issues that should be addressed during design are:

- strong ground shaking during an earthquake and the potential for seismically-induced ground movement,
- settlement due to placement of new fill for site grading,
- presence of the marine deposits
- presence of expansive soils,
- appropriate foundation support, and
- settlement behavior of the proposed foundation.

6.1 Geologic Hazards

During a major earthquake, strong ground shaking is expected to occur at the site. Strong shaking during an earthquake can result in ground failure such as those associated with ground rupture, soil liquefaction[9], lateral spreading[10], and seismic densification[11]. Each of these conditions has been evaluated based on our literature review, field investigation and analysis, and is discussed in this section.

6.1.1 Ground Rupture

Historically, ground surface ruptures closely follow the trace of geologically young faults. The site is not within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act and no known active or potentially active faults exist on the site. Therefore, we conclude the risk of fault offset at the site from a known fault is low. In a seismically active area, the remote possibility exists for future faulting in areas where no faults previously

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9 Liquefaction is a phenomenon in which saturated, cohesionless soil experiences a temporary loss of strength due to the buildup of excess pore water pressure, especially during cyclic loading such as that induced by earthquakes. Soil most susceptible to liquefaction is loose, clean, saturated, uniformly graded, fine-grained sand and silt of low plasticity that is relatively free of clay.

10 Lateral spreading is a phenomenon in which surficial soil displaces along a shear zone that has formed within an underlying liquefied layer. Upon reaching mobilization, the surficial blocks are transported downslope or in the direction of a free face by earthquake and gravitational forces.

11 Seismic densification is a phenomenon in which non-saturated, cohesionless soil is densified by earthquake vibrations, causing differential settlement.

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existed; however, we conclude the risk of surface faulting and consequent secondary ground failure is low.

6.1.2 Liquefaction and Seismic Densification and Associated Hazards

When a saturated, cohesionless soil liquefies during a major earthquake, it experiences a temporary loss of shear strength as a result of a transient rise in excess pore water pressure generated by strong ground motion. Flow failure, lateral spreading, differential settlement, loss of bearing, ground fissures, and sand boils are evidence of excess pore pressure generation and liquefaction.

On the basis of our review of the subsurface information obtained from this and other investigations, we conclude a potential for liquefaction may exist beneath the project site. Several feet of medium dense sand with varying amounts of clay and silt are likely present beneath the anticipated high groundwater level. Furthermore, because the banks of the Napa River border the property, the potential for lateral spreading towards the river exists. Liquefaction and lateral spreading potential at the project site should be evaluated during the final geotechnical investigation.

Under this current feasibility study, we were not able to evaluate the stability the existing Napa River shoreline for slope stability, landslides or erosion. However, these geologic hazards should be evaluated during a future detailed geotechnical investigation study. No springs or seepages were observed on site.

Sand was not encountered above the groundwater level; therefore, the potential for seismic densification is low.

6.2 Ground Surface Settlement

A grading plan for the project is currently not available. However, we understand preliminary plans include the placement of up to four feet of fill is to raise the general grade level of the site.

Where encountered and tested, the marine deposit is normally to slightly overconsolidated; therefore, primary settlement is complete under the weight of the existing fill. Where new fill or building loads are placed, a new cycle of primary consolidation will begin and additional settlement will occur. Depending on the building loads, amount of new fill, the present grades, and the variable existing fill and marine deposit thickness, settlements will differ across the site. Preliminary ranges of predicted settlement for various heights of new fill are shown on Table 3.

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TABLE 3
Preliminary Estimates of Consolidation Settlement of Marine Deposit Due to Placement of New Fill

Height of New Fill (feet)	Settlement (inches)
1	1.5 to 2.5
2	3 to 4
3	4 to 5
4	5.5 to 6.5
5	6.5 to 7.5

Where the marine deposit is <u>not</u> present, we estimate up to one inches of total settlement may occur for about one to two feet of new fill. If three to five feet of fill is placed, we estimate up to 1½ inches of settlement may occur.

Settlement could have adverse effects on site drainage, hardscape improvements, transitions between on-grade and pile-supported structures. Settlement will also create a downward frictional load on piles, as discussed in the next section.

6.3 Building Foundations

We understand preliminary plans for the project site include demolishing existing buildings and building new structures that will be three to four stories high, but may be up to seven stories tall. Tilt-up structures up to three stories are also planned.

The site is blanketed by a layer of moderately to highly expansive near-surface soil. Expansive soil changes volume during seasonal fluctuations in moisture content. These volume changes can cause cracking of foundations and floor slabs. Therefore, foundations and slabs should be designed and constructed to resist the effects of expansive soil. These effects can be mitigated by moisture conditioning the expansive soil, providing select, non-expansive fill below interior and exterior slabs and supporting foundations below the zone of moisture change.

Where the marine deposit is not present, structures can be supported on either a shallow spread-type foundation or driven piles, depending on the weight of the new building. If the settlement estimated for shallow foundations prove to be excessive, a deep foundation deriving its support from the stiff alluvial deposits can be used.

Where the marine deposit is present, it will consolidate under the weight of the building load and/or the new fill; the magnitude of settlement at the project site will be influenced by several factors including the thickness of the fill and the marine deposit. Therefore, shallow foundations are not considered appropriate for proposed structures, and deep foundations consisting of piles should be considered.

6.3.1 Shallow Foundations

If shallow foundations are used, the structure can be supported well-reinforced continuous footings, tied at column locations or a mat. The continuous perimeter footings should extend below the zone of seasonal moisture change (below a depth of at least three feet below existing grade). The continuous perimeter footing will act as a barrier to reduce the potential for moisture change beneath the slab-on-grade floors. Assuming a 500 kip column load and an allowable dead plus live load bearing pressure of 3,300 pounds per square feet (psf), we estimate total settlement of a properly constructed spread footing may be up to two inches and differential settlement may be up to one inch over a lateral distance of 30 feet.

If a mat foundation is used, it should settle less than a continuous footings; we estimate settlements may be up to one inch for a seven-story building. Differential settlement will depend on the rigidity of the mat. For preliminary design of a mat using the modulus of subgrade reaction method, we recommend a modulus of subgrade reaction, k, of 15 kips per cubic foot (kcf).

In the event that some of the structures include a basement, they may be supported on a mat foundation.

6.3.2 Deep Foundations

Because of the size of the site and the limited subsurface information available, the most appropriate pile type is difficult to establish. Types of piles that should be considered during final design include prestressed, precast concrete piles, steel H-piles, Tubex and auger cast-in-place piles[12], and geopiers[13]. The most appropriate pile type should be determined during the final geotechnical investigation at each parcel. The pile type chosen should depend on the building structural load requirements, settlement behavior, required lengths and cost.

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12 Auger cast-in-place (ACIP) concrete piles are installed by rotating a continuous flight auger into the ground to the design depth. The hole is backfilled with high strength flowable cement based grout that is pumped under pressure from the auger tip. Pumping is discontinued once the auger is fully withdrawn from the ground and reinforcing steel is then placed into the grout while it is still fluid.

13 A Geopier Rammed Aggregate Pier is a stiff and highly densified inclusion of rammed crushed aggregate that is installed by drilling a 24-inch to 36-inch diameter hole and ramming thin lifts of well-graded aggregate within the hole.

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Piles should gain support in skin friction in the alluvial deposits. We estimate preliminary allowable dead and live load capacity for a 14-inch square pile, 60 to 65 feet long, will be approximately 240 kips (factor of safety 2.0). The capacity may be increased by one-third for total loads, including wind or seismic forces. Piles should be spaced no closer than three pile-widths on centers to avoid reductions to the axial capacities due to group effects.

Piles may be shorter if end bearing is encountered in the dense to very dense sands and gravels within the alluvium. However, this will need to be determined during a final investigation.

Where the marine deposit is present and where new fill will be added, the piles may be subject to downdrag[14] loads. We preliminarily estimate a downdrag load of 35 kips; however the downdrag load will vary depending upon the marine deposit thickness. Downdrag loads should be deducted from the total allowable compressive capacity of the piles to obtain the capacity available for building support.

Piles will develop resistance to temporary uplift loads through skin friction along their perimeter surfaces. For a 60 to 65 foot long pile, we preliminary recommend an allowable uplift capacity for 14-inch square pile of 320 kips. This capacity includes a factor of safety of 1.5.

6.4 Bridge Foundations

We understand a bridge is proposed at the southeast property line. Based on preliminary correspondences from the project structural engineer, a pile foundation is being considered for the bridge structure.

Types of piles that should be considered during final design include prestressed, precast concrete piles, steel H-piles, Tubex and auger cast-in-place piles. The most appropriate pile type should be determined during the final geotechnical investigation for the bridge. The pile type chosen should depend on the building structural load requirements, settlement behavior, required lengths and cost.

Piles should gain support in skin friction in the alluvial deposits. We estimate preliminary allowable dead and live load capacities for 14-inch square pile, 60 to 65 feet long, will be approximately 240 kips (factor of safety 2.0). The capacity may be increased by one-third for total loads, including wind or seismic forces. Piles should be spaced no closer than three pile-widths on centers to avoid reductions to the axial capacities due to group effects.

14 Downdrag is the additional load transferred to the pile by the downward movement or settlement of the soil relative to the pile. The downward movement imposes a "negative" skin friction force on the pile.

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Piles may be shorter if end bearing is encountered in the dense to very dense sands and gravels within the alluvium. However, this will need to be determined during a final investigation.

Piles will develop resistance to temporary uplift loads through skin friction along their perimeter surfaces. For a 60 to 65 foot long 14-inch square pile, we recommend a preliminary allowable uplift capacity of 320 kips. This capacity includes a factor of safety of 1.5.

The piles for the bridge foundation should develop lateral resistance from the passive pressure acting on the upper portion of the piles and their structural rigidity. The allowable lateral capacity of the piles depends on the pile stiffness, the strength of the surrounding soil, axial load on the pile, the allowable deflection at the pile top and the ground surface and the allowable moment capacity of the pile.

We have calculated preliminary lateral capacity for ½-inch lateral deflection at the top of pile for a 14-inch prestressed, precast concrete piles (PSPC) with an axial compressive load of 240 kips. The lateral loads for both fixed- and free-head conditions are presented in Table 4.

TABLE 4

Preliminary Results of Lateral Load Analyses for 0.5-inch Deflection at top of 14-inch PSPC Piles

Pile Head Connection	Computed Lateral Load at 0.5-inch Deflection (kips)	Computed Maximum Bending Moment (kip-feet)	Depth to Maximum Bending Moment (Below Top of Pile) (feet)
Fixed	42	180	0
Free	20	70	6

These lateral and moment capacities are for single piles only. For pile groups where the piles are spaced three pile-widths on centers, the lateral capacity of the piles should be reduced by 20 percent for groups of two to five piles and by 30 percent for groups of six or more piles.

Additional lateral load resistance can be developed by passive resistance acting against the face of the pile caps, grade beams and skirt walls. An equivalent fluid weight of 280 pounds per cubic foot (pcf) and 130 pcf may be used to compute passive resistance above and below the water table (design groundwater level of Elevation 3 feet). These values include a factor of

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safety of 1.5. Because of settlement, the upper one foot of soil should be ignored in computing passive resistance.

6.5 Groundwater

Groundwater was measured at the site at Elevations ranging from 2.8 to -2 feet. On the basis of our knowledge of groundwater conditions in the area, we conclude a groundwater elevation of 3 feet (Mean Sea Level) should be used in design.

6.6 Seismic Design

6.6.1 2001 California Building Code

The site is in Seismic Zone 4. The closest distance to a known fault is approximately 1.4 km to the West Napa Fault (B-type fault). For seismic design in accordance with the 2001 California Building Code, we recommend the following:

- Soil profile type S_D
- N_a of 1.3 and N_v of 1.6.

Laboratory tests performed for this study indicate there is less than 10 feet of soft clays. If future studies determine there is more than 10 feet of soft clay, then those areas should be designated a soil profile type S_E.

6.6.2 Caltrans Seismic Design Criteria

For design of the proposed bridge, we recommend ARS Curve for soil type D, magnitude 6.5 ± 0.25 and peak rock acceleration of 0.6g. Because the site is in the near-field and the depth to bedrock is greater than 250 feet, the standard ARS Curve should be adjusted in accordance with Section 6.1.2.1 of the Caltrans Seismic Design Criteria. Specifically, the spectra should be adjusted using the values in Table 5.

TABLE 5
Adjustment of Standard Caltrans ARS Curve for Near-Source and Depth to Bedrock

Spectral Period (sec)	Near-Source Factor	Spectral Period (sec)	Depth to Bedrock Factor
0	1.0	0	1.0
0.5	1.0	0.5	1.0
0.75	1.1	0.75	1.05
1.0	1.2	1.0	1.1
		≥ 1.5	1.2

6.7 Floor Slabs

To reduce water vapor transmission through the floor slab, we recommend installing a capillary moisture break and a water vapor retarder beneath the floor. A capillary moisture break consists of at least four inches of clean, free-draining gravel or crushed rock. The vapor retarder should meet the requirements for Class C vapor retarders stated in ASTM E1745-97. The vapor retarder should be placed in accordance with the requirements of ASTM E1643-98. These requirements include overlapping seams by six inches, taping seams, and sealing penetrations in the vapor retarder. The vapor retarder should be covered with two inches of sand to aid in curing the concrete and to protect the vapor retarder during slab construction. The particle size of the gravel/crushed rock and sand should meet the gradation requirements presented in Table 6.

TABLE 6
Gradation Requirements for Capillary Moisture Break

Sieve Size	Percentage Passing Sieve
Gravel or Crushed Rock	
1 inch	90 – 100
3/4 inch	30 – 100
1/2 inch	5 – 25
3/8 inch	0 – 6
Sand	
No. 4	100
No. 200	0 – 5

The sand overlying the membrane should be dry at the time concrete is placed. Excess water trapped in the sand could eventually be transmitted as vapor through the slab. If rain is forecast prior to pouring the slab, the sand should be covered with plastic sheeting to avoid wetting. If the sand becomes wet, concrete should not be placed until the sand has been dried or replaced.

Concrete mixes with high water/cement (w/c) ratios result in excess water in the concrete, which increases the cure time and results in excessive vapor transmission through the slab. Therefore, concrete for the floor slab should have a low w/c ratio - less than 0.50. If approved by the project structural engineer, the sand can be eliminated and the concrete can be placed directly over the vapor retarder, provided the w/c ratio of the concrete does not exceed 0.45 and water is not added in the field. If necessary, workability should be increased by adding plasticizers. In addition, the slab should be properly cured.

To reduce the effects of expansive soil, we recommend the building slab-on-grade and a capillary break/vapor retarder be underlain by at least 24 inches of non-expansive select fill. Depending on the final finish floor elevations, it may be necessary to overexcavate beneath the building footprint to allow for the proper thickness of select fill beneath the moisture barrier or floor slab. The select fill should be placed and compacted in accordance with Section 6.8.

6.8 Site Preparation and Grading

In areas to receive improvements (including buildings and exterior concrete slabs), site preparation should include the removal of all existing buildings, foundations, slabs, pavements, and underground utilities. Stripped materials should be removed from the site or stockpiled for later use in landscaped areas, if approved by the architect. The pavement material, including asphalt, may be segregated from organic topsoil and may be used as compacted fill, provided it meets the fill requirements and is acceptable from an environmental standpoint. The asphalt should be broken into fragments smaller than three inches in maximum dimension and mixed with soil to comprise less than 20 percent by weight of the fill; a higher percentage of asphalt fragments may be difficult to compact. The stripped organic soil can be stockpiled for later use in landscaped areas, if approved by the architect; organic topsoil should not be used as compacted fill.

Because of the presence of the near-surface onsite expansive clay, we recommend the proposed building pads and 5 feet beyond their perimeter be overexcavated and recompacted. The overexcavation material should be moisture conditioned and recompacted at three percent over optimum moisture content and compacted to at least 88 to 93 percent relative compaction. Areas receiving exterior slab-on-grade should also be overexcavated and moisture conditioned and recompacted as recommended before. We preliminarily recommend 12 inches of select fill be placed beneath building slab-on-grade floors over the overexcavated and recompacted soil. If more than 12 inches of fill is required to raise building pads, only the top 12 inches need be

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Mr. Caspar Mol
Napa Redevelopment Partners
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select fill. The final thickness of select fill should be confirmed during a final geotechnical investigation. The surface exposed by excavation/stripping should be scarified to a depth of at least six inches, moisture-conditioned 2 to 5 percent above the optimum moisture content, and compacted to at least 90 percent relative compaction[15]. The exposed ground surface should be kept moist during subgrade preparation.

Select fill should consist of either on-site or imported soil that is non-corrosive, free of organic matter, smaller than three inches in greatest dimension, has a liquid limit less than 40 and a plasticity index less than 12, and is approved by the geotechnical engineer. Laboratory tests indicate the on-site soil does not meet this criteria; however, this should be evaluated during the final geotechnical investigation. Select fill should be placed in horizontal layers not exceeding eight inches in loose thickness, moisture-conditioned to above the optimum moisture content, and compacted to at least 90 percent relative compaction. The upper six inches of the soil subgrade in pavement areas should be compacted to at least 95 percent relative compaction.

Temporary cut slopes in the fill above the groundwater level should be no steeper than 1.5:1 (horizontal to vertical). Cut slopes below groundwater should be inclined no steeper than 3:1, provided the excavation is dewatered. Permanent slopes above the groundwater level should be no steeper than 2:1.

To prevent erosion, surface drainage should be directed away the face of any excavation.

6.9 Flexible Pavement

The State of California resistance value (R-value) method for flexible pavement design was used to develop recommendations for the asphalt pavement sections. We have provided preliminary pavement sections for traffic indices of 5.0 and 6.0. Actual traffic indices should be determined through a traffic engineer's analysis of expected automobile and truck traffic at the site.

Laboratory tests results indicate the existing soil at S-1 bulk sample location has an R-value of 76. The pavement sections presented on Table 7 below are based on an R-value of 70. During the final geotechnical investigation, the R-value of the actual subgrade soil should be re-evaluated.

---

15 Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same material, as determined by the ASTM D1557-00 laboratory compaction procedure.

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TABLE 7
Recommended Flexible Pavement Sections

TI	Asphalt Concrete (inches)	Class 2 Aggregate Base (R = 78) (inches)
5.0	2.5	6
6.0	3.0	6

Aggregate base should conform to Section 26-1.02A of the current Caltrans Standard Specifications. All aggregate base should be compacted to at least 95 percent relative compaction. The top six inch of the subgrade soil should also be compacted to at least 95 percent relative compaction.

6.10 Concrete Pavement

Concrete pavement, if used, should be designed based on a maximum single-axle load of 20,000 pounds and a maximum tandem axle of 32,000 pounds. The recommended rigid pavement section for these axle loads is six inches of Portland cement concrete over six inches of Class 2 aggregate base. The pavement section should rest on at least six inches of select fill.

The modulus of rupture of the concrete should be at least 500 psi at 28 days. Contraction joints should be constructed at 15-foot spacing. Where the outer edge of a concrete pavement meets asphalt pavement, the concrete slab should be thickened by 50 percent at a taper not to exceed a slope of 1 in 10. For loading docks, we recommend the slab be reinforced with a minimum of No. 4 bars at 16-inch-spacing in both directions. Recommendations for subgrade preparation and aggregate base compaction for concrete pavement are the same as those we have described for asphalt pavement.

6.11 Final Investigation

During final design, a detailed foundation investigation should be performed for each new project. The investigation should include test borings, Cone Penetration Tests (CPTs), laboratory tests, as appropriate to develop foundation design criteria. If you have any questions, please call.

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We trust this letter provides the information you need.

Sincerely yours,
TREADWELL & ROLLO, INC.

Serena T. Jang
Geotechnical Engineer

Ramin Golesorkhi
Geotechnical Engineer

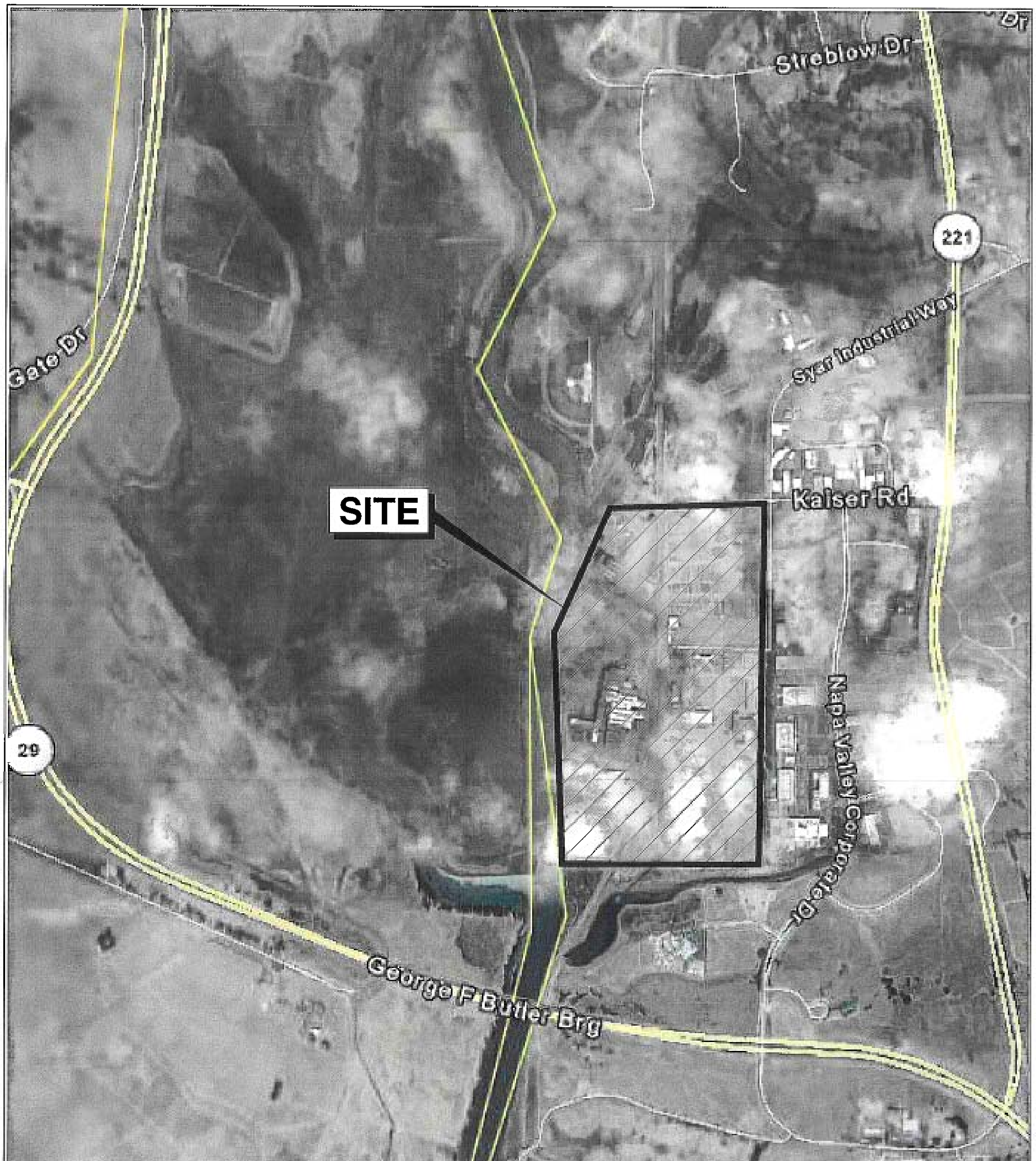
44670102.RG

Attachment: Figures
Appendix A – Boring Logs
Appendix B – Laboratory Test Results

REGISTERED PROFESSIONAL ENGINEER — RAMIN GOLESORKHI — GE 2351 — Exp. 6/30/08 — GEOTECHNICAL — STATE OF CALIFORNIA

Treadwell&Rollo

FIGURES



Base map: Google Earth
Napa County
2006

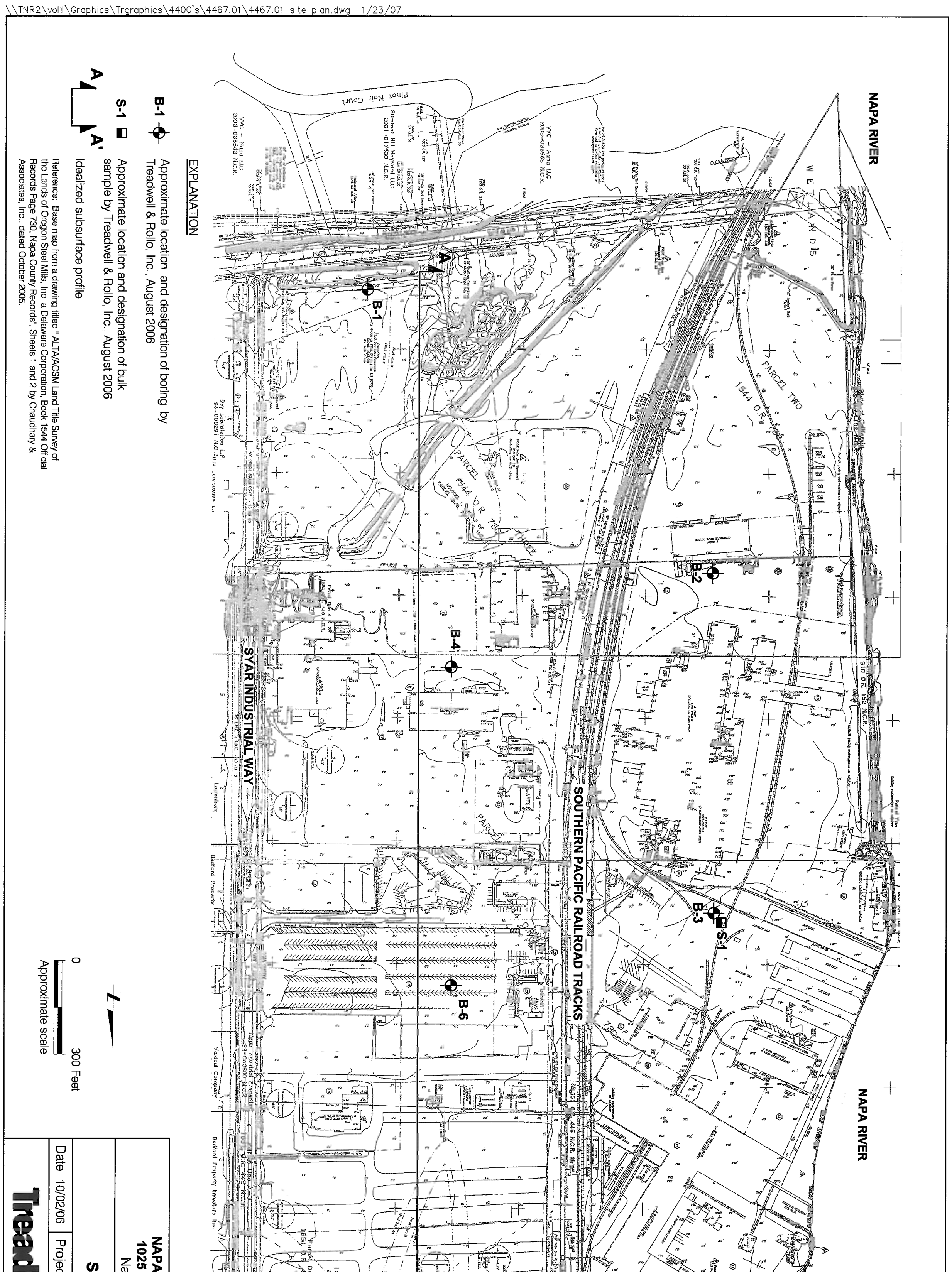
0 1/4 1/2 Mile
Approximate scale

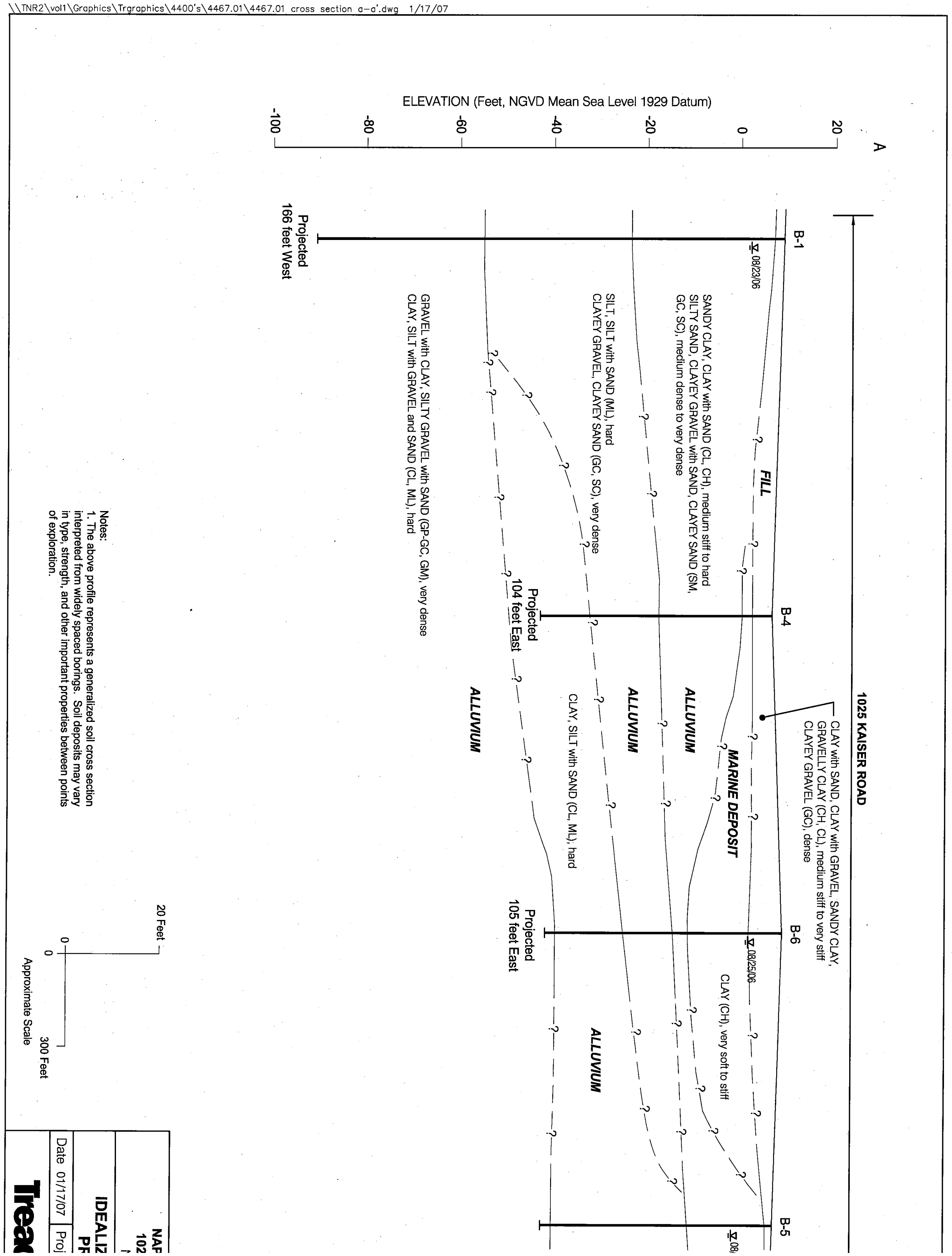
NAPA PIPE FACILITY
1025 KAISER ROAD
Napa, California

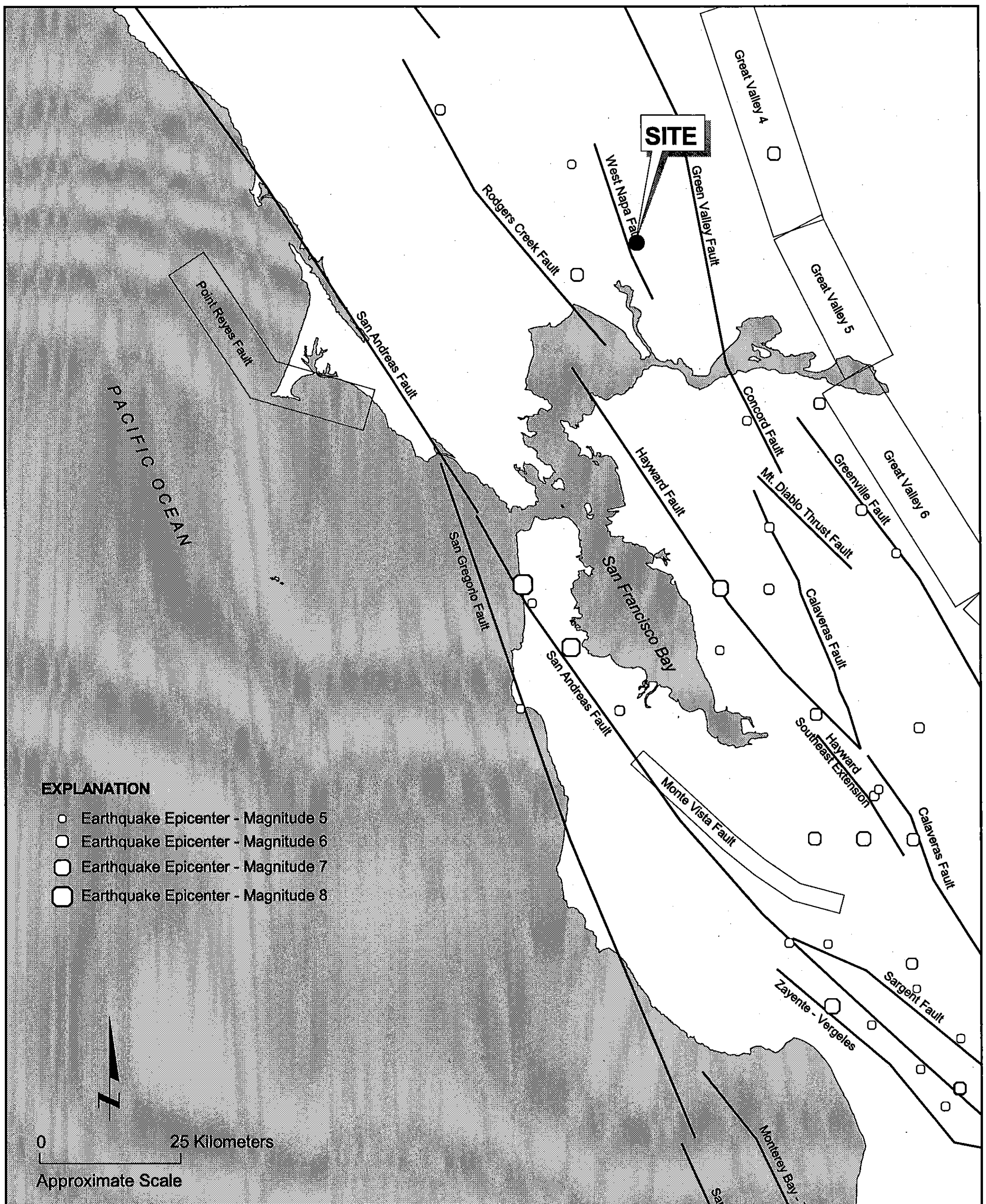
Treadwell&Rollo

SITE LOCATION MAP

Date 10/02/06 | Project No. 4467.01 | Figure 1


\\TNR2\vol1\Graphics\Trgraphics\4400's\4467.01\4467.01 site plan.dwg 1/23/07
EXPLANATION
B-1
Approximate location and designation of boring by Treadwell & Rollo, Inc., August 2006
S-1
Approximate location and designation of bulk sample by Treadwell & Rollo, Inc., August 2006
A A'
Idealized subsurface profile
Reference: Base map from a drawing titled " ALTA/ACSM Land Title Survey of the Lands of Oregon Steel Mills, Inc. a Delaware Corporation, Book 1544 Official Records Page 730, Napa County Records", Sheets 1 and 2 by Chaudhary & Associates, Inc., dated October 2005.
NAPA RIVER
NAPA RIVER
SYAR INDUSTRIAL WAY
SOUTHERN PACIFIC RAILROAD TRACKS
PARCEL TWO
B-2
B-3
B-4
B-6
S-1
0
300 Feet
Approximate scale
Date 10/02/06
Treadwell


\\TNR2\vol1\Graphics\Trgraphics\4400's\4467.01\4467.01 cross section a-a'.dwg 1/17/07
A
ELEVATION (Feet, NGVD Mean Sea Level 1929 Datum)
20
0
-20
-40
-60
-80
-100
1025 KAISER ROAD
B-1
B-4
B-6
B-5
Projected 166 feet West
Projected 104 feet East
Projected 105 feet East
08/23/06
08/25/06
FILL
MARINE DEPOSIT
ALLUVIUM
SANDY CLAY, CLAY with SAND (CL, CH), medium stiff to hard
SILTY SAND, CLAYEY GRAVEL with SAND, CLAYEY SAND (SM, GC, SC), medium dense to very dense
SILT, SILT with SAND (ML), hard
CLAYEY GRAVEL, CLAYEY SAND (GC, SC), very dense
GRAVEL with CLAY, SILTY GRAVEL with SAND (GP-GC, GM), very dense
CLAY, SILT with GRAVEL and SAND (CL, ML), hard
CLAY with SAND, CLAY with GRAVEL, SANDY CLAY, GRAVELLY CLAY (CH, CL), medium stiff to very stiff
CLAYEY GRAVEL (GC), dense
CLAY, SILT with SAND (CL, ML), hard
CLAY (CH), very soft to stiff
Notes:
1. The above profile represents a generalized soil cross section interpreted from widely spaced borings. Soil deposits may vary in type, strength, and other important properties between points of exploration.
20 Feet
0
0
300 Feet
Approximate Scale
IDEALIZ
Date 01/17/07



NOTES:
Digitized data for fault coordinates and earthquake catalog was developed by the California Department of Conservation Division of Mines and Geology. The historic earthquake catalog includes events from January 1800 to December 2000.

NAPA PIPE FACILITY **1025 KAISER ROAD** Napa, California	**MAP OF MAJOR FAULTS AND EARTHQUAKE EPICENTERS IN THE SAN FRANCISCO BAY AREA**
Treadwell&Rollo	Date: 10/16/06 | Project No. 4467.01 | Figure 4

I	**Not felt by people, except under especially favorable circumstances. However, dizziness or nausea may be experienced.** Sometimes birds and animals are uneasy or disturbed. Trees, structures, liquids, bodies of water may sway gently, and doors may swing very slowly.
II	**Felt indoors by a few people, especially on upper floors of multi-story buildings, and by sensitive or nervous persons.** As in Grade I, birds and animals are disturbed, and trees, structures, liquids and bodies of water may sway. Hanging objects swing, especially if they are delicately suspended.
III	**Felt indoors by several people, usually as a rapid vibration that may not be recognized as an earthquake at first. Vibration is similar to that of a light, or lightly loaded trucks, or heavy trucks some distance away. Duration may be estimated in some cases.** Movements may be appreciable on upper levels of tall structures. Standing motor cars may rock slightly.
IV	**Felt indoors by many, outdoors by a few. Awakens a few individuals, particularly light sleepers, but frightens no one except those apprehensive from previous experience. Vibration like that due to passing of heavy, or heavily loaded trucks. Sensation like a heavy body striking building, or the falling of heavy objects inside.** Dishes, windows and doors rattle; glassware and crockery clink and clash. Walls and house frames creak, especially if intensity is in the upper range of this grade. Hanging objects often swing. Liquids in open vessels are disturbed slightly. Stationary automobiles rock noticeably.
V	**Felt indoors by practically everyone, outdoors by most people. Direction can often be estimated by those outdoors. Awakens many, or most sleepers. Frightens a few people, with slight excitement; some persons run outdoors.** Buildings tremble throughout. Dishes and glassware break to some extent. Windows crack in some cases, but not generally. Vases and small or unstable objects overturn in many instances, and a few fall. Hanging objects and doors swing generally or considerably. Pictures knock against walls, or swing out of place. Doors and shutters open or close abruptly. Pendulum clocks stop, or run fast or slow. Small objects move, and furnishings may shift to a slight extent. Small amounts of liquids spill from well-filled open containers. Trees and bushes shake slightly.
VI	**Felt by everyone, indoors and outdoors. Awakens all sleepers. Frightens many people; general excitement, and some persons run outdoors.** Persons move unsteadily. Trees and bushes shake slightly to moderately. Liquids are set in strong motion. Small bells in churches and schools ring. Poorly built buildings may be damaged. Plaster falls in small amounts. Other plaster cracks somewhat. Many dishes and glasses, and a few windows break. Knickknacks, books and pictures fall. Furniture overturns in many instances. Heavy furnishings move.
VII	**Frightens everyone. General alarm, and everyone runs outdoors.** People find it difficult to stand. Persons driving cars notice shaking. Trees and bushes shake moderately to strongly. Waves form on ponds, lakes and streams. Water is muddied. Gravel or sand stream banks cave in. Large church bells ring. Suspended objects quiver. Damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary buildings; considerable in poorly built or badly designed buildings, adobe houses, old walls (especially where laid up without mortar), spires, etc. Plaster and some stucco fall. Many windows and some furniture break. Loosened brickwork and tiles shake down. Weak chimneys break at the roofline. Cornices fall from towers and high buildings. Bricks and stones are dislodged. Heavy furniture overturns. Concrete irrigation ditches are considerably damaged.
VIII	**General fright, and alarm approaches panic.** Persons driving cars are disturbed. Trees shake strongly, and branches and trunks break off (especially palm trees). Sand and mud erupts in small amounts. Flow of springs and wells is temporarily and sometimes permanently changed. Dry wells renew flow. Temperatures of spring and well waters varies. Damage slight in brick structures built especially to withstand earthquakes; considerable in ordinary substantial buildings, with some partial collapse; heavy in some wooden houses, with some tumbling down. Panel walls break away in frame structures. Decayed pilings break off. Walls fall. Solid stone walls crack and break seriously. Wet grounds and steep slopes crack to some extent. Chimneys, columns, monuments and factory stacks and towers twist and fall. Very heavy furniture moves conspicuously or overturns.
IX	**Panic is general.** Ground cracks conspicuously. Damage is considerable in masonry structures built especially to withstand earthquakes; great in other masonry buildings - some collapse in large part. Some wood frame houses built especially to withstand earthquakes are thrown out of plumb, others are shifted wholly off foundations. Reservoirs are seriously damaged and underground pipes sometimes break.
X	**Panic is general.** Ground, especially when loose and wet, cracks up to widths of several inches; fissures up to a yard in width run parallel to canal and stream banks. Landsliding is considerable from river banks and steep coasts. Sand and mud shifts horizontally on beaches and flat land. Water level changes in wells. Water is thrown on banks of canals, lakes, rivers, etc. Dams, dikes, embankments are seriously damaged. Well-built wooden structures and bridges are severely damaged, and some collapse. Dangerous cracks develop in excellent brick walls. Most masonry and frame structures, and their foundations are destroyed. Railroad rails bend slightly. Pipe lines buried in earth tear apart or are crushed endwise. Open cracks and broad wavy folds open in cement pavements and asphalt road surfaces.
XI	**Panic is general.** Disturbances in ground are many and widespread, varying with the ground material. Broad fissures, earth slumps, and land slips develop in soft, wet ground. Water charged with sand and mud is ejected in large amounts. Sea waves of significant magnitude may develop. Damage is severe to wood frame structures, especially near shock centers, great to dams, dikes and embankments, even at long distances. Few if any masonry structures remain standing. Supporting piers or pillars of large, well-built bridges are wrecked. Wooden bridges that "give" are less affected. Railroad rails bend greatly and some thrust endwise. Pipe lines buried in earth are put completely out of service.
XII	**Panic is general.** Damage is total, and practically all works of construction are damaged greatly or destroyed. Disturbances in the ground are great and varied, and numerous shearing cracks develop. Landslides, rock falls, and slumps in river banks are numerous and extensive. Large rock masses are wrenched loose and torn off. Fault slips develop in firm rock, and horizontal and vertical offset displacements are notable. Water channels, both surface and underground, are disturbed and modified greatly. Lakes are dammed, new waterfalls are produced, rivers are deflected, etc. Surface waves are seen on ground surfaces. Lines of sight and level are distorted. Objects are thrown upward into the air.

NAPA PIPE FACILITY **1025 KAISER ROAD** Napa, California	**MODIFIED MERCALLI INTENSITY SCALE**		
Treadwell&Rollo	Date 10/02/06	Project No. 4467.01	Figure 5

Treadwell&Rollo

APPENDIX A

BORING LOGS

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-1

PAGE 1 OF 4

Boring location: See Site Plan, Figure 2	Logged by: M. Zinsley
Date started: 8/23/06	Date finished: 8/23/06
Drilling method: Rotary Wash	
Hammer weight/drop: 140 lbs./30-inches	Hammer type: Automatic Hammer
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)	

DEPTH (feet)	Sampler Type	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION (Ground Surface Elevation: 9.0 feet[2])	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–1			CH	CLAY with SAND and GRAVEL (CH) brown, moist (FILL)						
1–3	SPT (2)	13	CL	CLAY with SAND (CL) dark brown, stiff, moist, with concrete rubble and iron staining; at 1 foot: LL = 45, PL = 17, PI = 28, see Figure B-10 (FILL)						
3–10	S&H (3)	18	CH	SANDY CLAY (CH) yellow-brown with dark brown mottling, very stiff, moist, with silt						
6	S&H	14		grades stiff with fine-grained gravel; LL = 57, PL = 26, PI = 31, see Figure B-10; ▽ (08/23/06, 5:00 p.m.)					32.6	81
10–14	S&H (10)	13	SC	CLAYEY SAND (SC) olive-brown, medium dense, wet				43.9	32.3	
14	SPT (15)	90	GC	CLAYEY GRAVEL with SAND (GC) light olive-brown, very dense, wet, fine to coarse-grained, angular to subrounded, with trace cobbles						
19–20	SPT (20)	41		grades dense						
23				some clay seams						
24–25	S&H (24)	35/3"		grades very dense						
29–30	SPT (30)	41								

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

Treadwell&Rollo

Project No.: 4467.01 Figure: A-1a

PROJECT:	NAPA PIPE FACILITY 1025 KAISER ROAD Napa, California	Log of Boring B-1 PAGE 2 OF 4

DEPTH (feet)	Sampler Type	Sample	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
	SPT		41	GC	CLAYEY GRAVEL with SAND (GC) (Continued) grades dense						
33				GC	CLAYEY GRAVEL (GC) olive-brown with red mottling, very dense, wet, coarse-grained and subangular, with some cobbles						
34	SPT		55/ 3.5"								
44	SPT		55/ 6"								
45					with rock fragments (greater than two-inch diameter), some sand and silt						
48					driller report easier drilling between 47 feet to 50 feet						
54	SPT		55/ 3"								
58					grades with increase clay content						
60											

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

Treadwell&Rollo

Project No.: 4467.01 | Figure: A-1b

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-1

DEPTH (feet)	SAMPLES: Sampler Type	SAMPLES: Sample	SAMPLES: SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	LABORATORY TEST DATA: Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
					CLAYEY GRAVEL (GC) (Continued)						
61	S&H	■	35/ 6"	GC							
62											
63					grades with increase gravel						
64					GRAVEL with CLAY (GP-GC)						
65					gray, very dense, wet, with basalt (?) fragments; hard drilling from 65 feet to 70 feet						
66											
67				GP-GC							
68											
69	SPT	■	55/ 1"								
70											
71					SILTY GRAVEL with SAND (GM)						
72					dark gray with orange-brown mottling, very dense, wet, fine to coarse grained, with cobbles						
73											
74											
75											
76											
77											
78					driller notes easier drilling at 79 feet, grades with increase fines in cuttings						
79											
80				GM							
81											
82											
83					driller notes harder drilling at 82 feet						
84	SPT	■	55/ 3"								
85											
86											
87											
88											
89											
90											

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

Treadwell&Rollo

Project No.: 4467.01

Figure: A-1c

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-1

PAGE 4 OF 4

DEPTH (feet)	Sampler Type	Sample	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
91–98				GM	SILTY GRAVEL with SAND (GM) (continued)						
99	SPT		55/ 2.5"	ML	SILT with GRAVEL with SAND (ML) yellow-brown with dark gray mottling, hard, wet						
100–120											

Boring terminated at a depth of 99.7 feet below ground surface.
Boring backfilled with cement grout.
Groundwater measured at a depth of 6.75 on 08/23/06 at 5:00 PM.

[1] S&H blow counts converted to SPT N-Values using a factor of 0.7. SPT blow counts converted to SPT N-Values using a factor of 1.1
[2] Elevations based on NGVD Mean Sea Level of 1929

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Project No.: 4467.01 | Figure: A-1d

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

PROJECT:	NAPA PIPE FACILITY 1025 KAISER ROAD Napa, California	**Log of Boring B-2** PAGE 1 OF 1

Boring location: See Site Plan, Figure 2

Logged by: M. Zinsley

Date started: 8/24/06 | Date finished: 8/24/06

Drilling method: Garbage barrel

Hammer weight/drop: 140 lbs./30-inches | Hammer type: Automatic Hammer

Sampler: Sprague & Henwood (S&H)

Ground Surface Elevation: 6.5 feet[2]

DEPTH (feet)	Sampler Type	Sample	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–1.5					18-inches thick Asphalt Concrete (AC) and Aggregate Base (AB)						
1.5–3.5	S&H	■	35/4"	CL	SANDY CLAY with GRAVEL (CL) light brown, very dense, wet						
3.5–13	S&H	■	15	CH	CLAY with GRAVEL (CH) gray, stiff, moist, with subrounded to rounded gravel, and trace wood fragments						
7					▽ (8/24/06, 11:00 a.m.) at 7 feet, detect hydrocarbon odor and sheen in groundwater. Black residue on auger and in cuttings. After consulting PES Environmental, hole abandoned at 13 feet. Rotary wash not used.						

FILL? (0–13 feet)

Depth scale: 1–30 feet

Boring terminated at a depth of 13 feet below ground surface.
Boring backfilled with cement grout.
Groundwater measured at a depth of 7 feet on 08/24/06 at 11:00 AM.

[1] S&H blow counts converted to SPT N-Values using a factor of 0.7. SPT blow counts converted to SPT N-Values using a factor of 1.1
[2] Elevations based on NGVD Mean Sea Level of 1929

Treadwell&Rollo

Project No.: 4467.01 | Figure: A-2

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-3

PAGE 1 OF 2

Boring location: See Site Plan, Figure 2
Logged by: M. Zinsley
Date started: 8/24/06 Date finished: 8/24/06
Drilling method: Rotary Wash
Hammer weight/drop: 140 lbs./30-inches Hammer type: Automatic Hammer
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT), Shelby Tube (ST)

Ground Surface Elevation: 6.5 feet[2]

DEPTH (feet)	SAMPLES: Sampler Type	SAMPLES: SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION		LABORATORY TEST DATA: Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–1				6-inch thick Asphaltic Concrete (AC) 15-inch thick Aggregate Base (AB)	FILL						
2–3			SC	CLAYEY SAND with GRAVEL (SC) brown and gray, medium dense, moist, with concrete fragments up to 2-inch diameter	FILL						
4	S&H	47/ 9"	SW	SAND (SW) brown, orange-brown, and pink-gray, very dense, moist	FILL						
6	S&H	55/ 5.5"	SW		FILL						
8–10	S&H	7	CH	CLAY (CH) dark gray, medium stiff, moist, with silt ▽ (08/24/06, 12:30 p.m.)	MARINE DEPOSIT						
14			CH		MARINE DEPOSIT					55.8	67
15	ST	10 psi	CH	Consolidation Test, see Figure B-1	MARINE DEPOSIT	TxUU	1,500	680		60.8	61
17			CH	with organics	MARINE DEPOSIT						
20			CH	grades with trace sand and fine gravel	MARINE DEPOSIT						
22	S&H	15	CH	grades stiff	MARINE DEPOSIT	TxUU	2,000	1,100		22.9	104
25–26			SM	SILTY SAND (SM) red-yellow, medium dense, wet							
27	S&H	25							68.1	31.1	
27–28			CH	CLAY (CH) light olive-brown and light orange-brown, very stiff, moist							
29–30	S&H	53/ 11.5"	CH	hard, with dark gray mottling		TxUU	2,400	3,020		24.9	102

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

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Project No.: 4467.01 Figure: A-3a

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-3

PAGE 2 OF 2

DEPTH (feet)	Sampler Type	Sample	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31				CH	CLAY (CH) (continued)						
32–33					CLAYEY GRAVEL with SAND (GC) red-yellow, very dense, wet, rounded to subangular, medium to coarse grained						
35	SPT		56	GC							
40	SPT		88								
44	S&H		35/ 6"	SC	CLAYEY SAND with GRAVEL (SC) yellow-brown, very dense, wet						
49	S&H		35/ 4.5"	SP	SAND (SP) light olive-brown, very dense, wet						

Boring terminated at a depth of 49.9 feet below ground surface.
Boring backfilled with cement grout.
Groundwater measured at a depth of 9 feet on 08/24/06 at 12:30 PM.

[1] S&H blow counts converted to SPT N-Values using a factor of 0.7. SPT blow counts converted to SPT N-Values using a factor of 1.1
[2] Elevations based on NGVD Mean Sea Level of 1929

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Project No.: 4467.01 | Figure: A-3b

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-4

PAGE 1 OF 2

Boring location: See Site Plan, Figure 2
Date started: 8/24/06 Date finished: 8/24/06
Drilling method: Rotary Wash
Hammer weight/drop: 140 lbs./30-inches Hammer type: Automatic Hammer
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

Logged by: M. Zinsley

DEPTH (feet)	SAMPLES: Sampler Type	SAMPLES: SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION (Ground Surface Elevation: 6.5 feet[2])		LABORATORY TEST DATA: Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–2	S&H	35/ 5"		6-inch thick Asphaltic Concrete 18-inches thick Aggregate Base (AB) with light brown clay	FILL						
2–4			CL	SANDY CLAY (CL) blue-gray and brown, medium stiff to stiff, moist	FILL						
4–6.5	S&H	17	CH	CLAY (CH) dark gray, very stiff, moist, with trace organics	MARINE DEPOSIT	TxUU	600	1,370		29.0	93
6.5–12.5	S&H	20	CL	SANDY CLAY (CL) light-brown, very stiff, moist							
12.5–17.5	S&H	60/ 10.5"	SM	SILTY SAND (SM) light olive-brown, very dense, moist to wet, well cemented, trace gravel							
17.5–22	S&H	45	CL	SANDY CLAY (CL) light olive-brown, hard, moist to wet, with silt							
22–24			SM	SILTY SAND (SM) light olive-brown, dense to very dense, wet							
24–30	SPT	55/ 6"	ML	SILT (ML) light olive-brown, hard, wet, with fine sand and clay							
29–30	S&H	35/ 4"	ML	grades to yellow-brown with olive mottling							

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

Treadwell&Rollo

Project No.: 4467.01 Figure: A-4a

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-4

PAGE 2 OF 2

DEPTH (feet)	SAMPLES: Sampler Type	SAMPLES: Sample	SAMPLES: SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	LABORATORY TEST DATA: Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31–34				ML	SILT (ML) (Continued)						
35	SPT		88/ 5.5"								
36–37				SC	CLAYEY SAND (SC) light olive-brown, very dense, wet						
38				CL	CLAY (CL) light olive-brown, hard, wet, with fine sand						
39–42	S&H		46	CH	CLAY (CH) green-gray, hard, wet, with trace fine sand and silt						
43–49	SPT (44); SPT (49)		55/ 6" (44); 55/ 5" (49)	ML	SILT and SAND (ML) light olive-brown, hard, wet, with fine sand lenses up to 6-inches thick						
50–60											

Boring terminated at a depth of 49.4 feet below ground surface.
Boring backfilled with cement grout.
Groundwater level obscured by drilling method.

[1] S&H blow counts converted to SPT N-Values using a factor of 0.7. SPT blow counts converted to SPT N-Values using a factor of 1.1
[2] Elevations based on NGVD Mean Sea Level of 1929

Treadwell&Rollo

Project No.: 4467.01 Figure: A-4b

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

PROJECT:	NAPA PIPE FACILITY 1025 KAISER ROAD Napa, California	**Log of Boring B-5** PAGE 1 OF 2

Boring location: See Site Plan, Figure 2

Date started: 8/24/06 | Date finished: 8/24/06

Drilling method: Rotary Wash

Hammer weight/drop: 140 lbs./30-inches | Hammer type: Automatic Hammer

Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

Logged by: M. Zinsley

LABORATORY TEST DATA

DEPTH (feet)	Sampler Type	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION (Ground Surface Elevation: 7 feet[2])	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–1.5			GC	CLAYEY GRAVEL (GC) dark yellow-brown and olive-brown, dense, moist, with sand, angular cobbles and asphalt fragments (FILL)						
2	S&H	36	CL	SANDY CLAY (CL) yellow-brown, hard, moist, weak to moderately cemented; at 1.5 feet: LL = 33, PL = 16, PI = 17, see Figure B-10					14.7	105
5	S&H	35	CL	grades with less fines, sand becomes more coarse-grained						
7			SC	CLAYEY SAND (SC) yellow-brown, dense, moist, coarse-grained						
9			SC	∇ (08/24/06, 4:00 p.m.)						
10	S&H	31	SC					21.2	19.9	
15	S&H	26	SC	grades to medium dense and wet						
18			CH	CLAY (CH) light olive-brown with orange-brown mottling, hard, wet, with silt and fine sand						
20	S&H	34	CH							
25	S&H	31	CH	Consolidation Test, see Figure B-2					31.4	91
29.5	S&H	31	CH	grades with less sand and trace gravel						

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

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Project No.: 4467.01 | Figure: A-5a

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-5

PAGE 2 OF 2

DEPTH (feet)	SAMPLES: Sampler Type	SAMPLES: Sample	SAMPLES: SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	LABORATORY TEST DATA: Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
	S&H		31		CLAY (CH) (Continued)						
31											
32											
33				CH	trace fine to medium sand and trace gravel in cuttings						
34											
35											
36											
37					CLAY (CL) light brown and red-brown, very stiff, wet						
38											
39											
40	S&H		34			TxUU	3,000	3,080		32.2	90
41											
42				CL							
43											
44											
45											
46											
47					CLAY (CL) dark gray, hard, wet, with trace sand						
48				CL							
49	S&H		35/ 6"								
50											
51											
52											
53											
54											
55											
56											
57											
58											
59											
60											

Boring terminated at a depth of 49.4 feet below ground surface.
Boring backfilled with cement grout.
Groundwater measured at a depth of 9 feet on 08/24/06 at 4:00 PM.

[1] S&H blow counts converted to SPT N-Values using a factor of 0.7. SPT blow counts converted to SPT N-Values using a factor of 1.1
[2] Elevations based on NGVD Mean Sea Level of 1929

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Project No.: 4467.01

Figure: A-5b

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

PROJECT:	NAPA PIPE FACILITY 1025 KAISER ROAD Napa, California	Log of Boring B-6 PAGE 1 OF 2

Boring location:	See Site Plan, Figure 2
Date started: 8/25/06	Date finished: 8/25/06
Drilling method:	Rotary Wash
Hammer weight/drop: 140 lbs./30-inches	Hammer type: Automatic Hammer
Sampler:	Sprague & Henwood (S&H), Standard Penetration Test (SPT), Shelby Tube (ST)
Logged by:	M. Zinsley

LABORATORY TEST DATA

Ground Surface Elevation: 8.8 feet[2]

DEPTH (feet)	Sampler Type	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Unit	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0				2-inches thick Asphaltic Concrete (AC)							
0–1				10-inches thick Aggregate Base (AB)							
1–2.5	S&H	28	CL	CLAY with GRAVEL (CL) gray and olive-brown, very stiff, moist, with trace cobbles	FILL						
2.5–6.5	S&H (3.5)	12	CH	GRAVELLY CLAY (CH) blue-gray, stiff, moist, with debris fragments	FILL						
5	S&H	10									
6				⊻ (08/25/06, 7:00 a.m.)							
6.5–20			CH	CLAY (CH) dark gray, medium stiff, moist, with organics	MARINE DEPOSIT						
10	S&H	5		dark brown						51.8	68
14–15	ST	50 psi		dark gray, very soft Consolidation Test, see Figure B-3		TxUU	1,500	200		58.1 115.2	61 40
19.5	ST	400 psi									
20–23			CL	SANDY CLAY (CL) green-gray, medium stiff to stiff, wet							
23				fine gravel lense approximately 6-inches thick							
23–28.5			ML	SILT with SAND (ML) orange-brown, hard, wet, with fine-grained sand and some clay							
24.5	S&H	35/5"									
27				fine gravel lense, 1 foot thick							
28.5–30	S&H (29.5)	35/5.5"	SC	CLAYEY SAND with GRAVEL (SC) yellow-brown with gray mottling, very dense, wet							

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

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Project No.: 4467.01 Figure: A-6a

PROJECT:	NAPA PIPE FACILITY 1025 KAISER ROAD Napa, California	**Log of Boring B-6** PAGE 2 OF 2

DEPTH (feet)	Sampler Type	Sample	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31				SC	SILT with SAND (ML) (Continued) cobble at 30 feet						
32											
33					CLAY (CL) light yellow-brown, hard, wet, with fine sand and silt, with occasional coarse gravel and cobbles						
34											
35	S&H	■	52								
36											
37											
38											
39					grades with increase silt						
40	S&H	■	37								
41				CL							
42											
43											
44											
45											
46											
47											
48											
49					CLAY (CL) blue-gray, hard, wet, with trace fine sand and silt						
50	S&H	■	63/ 11"	CL							
51											
52											
53											
54											
55											
56											
57											
58											
59											
60											

Boring terminated at a depth of 50.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater measured at a depth of 6 feet on 08/24/06 at 7:00 AM.

[1] S&H blow counts converted to SPT N-Values using a factor of 0.7. SPT blow counts converted to SPT N-Values using a factor of 1.1
[2] Elevations based on NGVD Mean Sea Level of 1929

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Project No.: 4467.01 | Figure: A-6b

TEST GEOTECH LOG 446701.GPJ TR.GDT 1/17/07

UNIFIED SOIL CLASSIFICATION SYSTEM			
Major Divisions		Symbols	Typical Names
Coarse-Grained Soils (more than half of soil > no. 200 sieve size	Gravels (More than half of coarse fraction > no. 4 sieve size)	GW	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	SW	Well-graded sands or gravelly sands, little or no fines
		SP	Poorly-graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
Fine -Grained Soils (more than half of soil < no. 200 sieve size)	Silts and Clays LL = < 50	ML	Inorganic silts and clayey silts of low plasticity, sandy silts, gravelly silts
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
		OL	Organic silts and organic silt-clays of low plasticity
	Silts and Clays LL = > 50	MH	Inorganic silts of high plasticity
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic silts and clays of high plasticity
Highly Organic Soils		PT	Peat and other highly organic soils

GRAIN SIZE CHART		
Classification	Range of Grain Sizes: U.S. Standard Sieve Size	Range of Grain Sizes: Grain Size in Millimeters
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 4.76
coarse	3" to 3/4"	76.2 to 19.1
fine	3/4" to No. 4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.074
coarse	No. 4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.074
Silt and Clay	Below No. 200	Below 0.074

Unstabilized groundwater level

Stabilized groundwater level

SAMPLE DESIGNATIONS/SYMBOLS

- Sample taken with Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter. Darkened area indicates soil recovered
- Classification sample taken with Standard Penetration Test sampler
- Undisturbed sample taken with thin-walled tube
- Disturbed sample
- Sampling attempted with no recovery
- Core sample
- Analytical laboratory sample
- Sample taken with Direct Push sampler

SAMPLER TYPE

C	Core barrel
CA	California split-barrel sampler with 2.5-inch outside diameter and a 1.93-inch inside diameter
D&M	Dames & Moore piston sampler using 2.5-inch outside diameter, thin-walled tube
O	Osterberg piston sampler using 3.0-inch outside diameter, thin-walled Shelby tube
PT	Pitcher tube sampler using 3.0-inch outside diameter, thin-walled Shelby tube
S&H	Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter
SPT	Standard Penetration Test (SPT) split-barrel sampler with a 2.0-inch outside diameter and a 1.5-inch inside diameter
ST	Shelby Tube (3.0-inch outside diameter, thin-walled tube) advanced with hydraulic pressure

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CLASSIFICATION CHART

Date 10/02/06 | Project No. 4467.01 | Figure A-7

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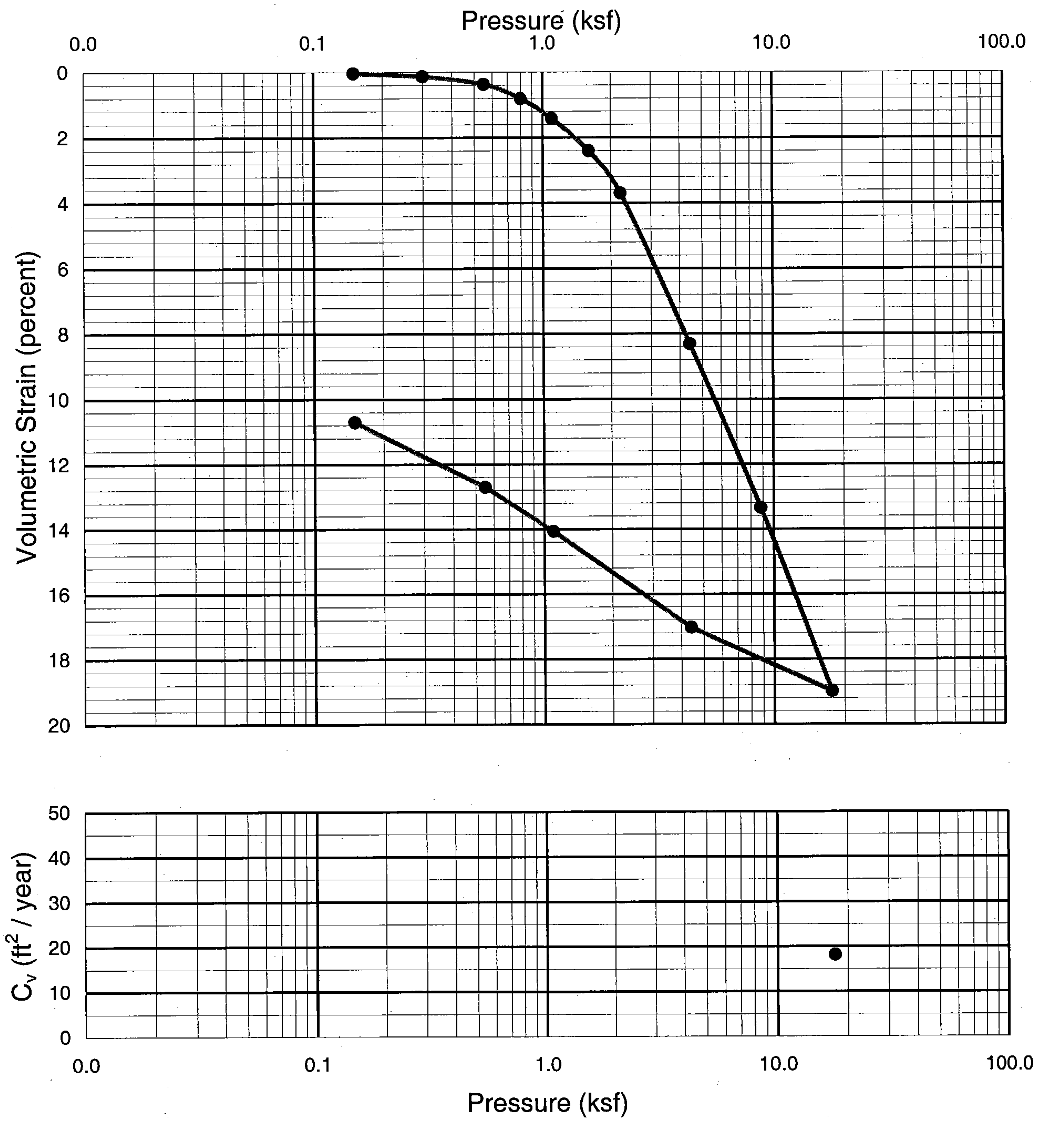
APPENDIX B

LABORATORY TEST RESULTS



Sampler Type: Sprague & Henwood				Condition	Before Test			After Test	
Diameter (in) 2.41	Height (in) 1.00			Water Content	w_o	55.8 %		w_f	46.1 %
Overburden Pressure, p_o	1,250	psf		Void Ratio	e_o	1.51		e_f	1.24
Preconsol. Pressure, p_c	1,800	psf		Saturation	S_o	99.8 %		S_f	100 %
Compression Ratio, $C_{\varepsilon c}$	0.19			Dry Density	γ_d	67 pcf		γ_d	75 pcf
LL	PL			PI			G_s 2.7		
Classification CLAY (CH), dark gray				Source B-3 at 14 feet					

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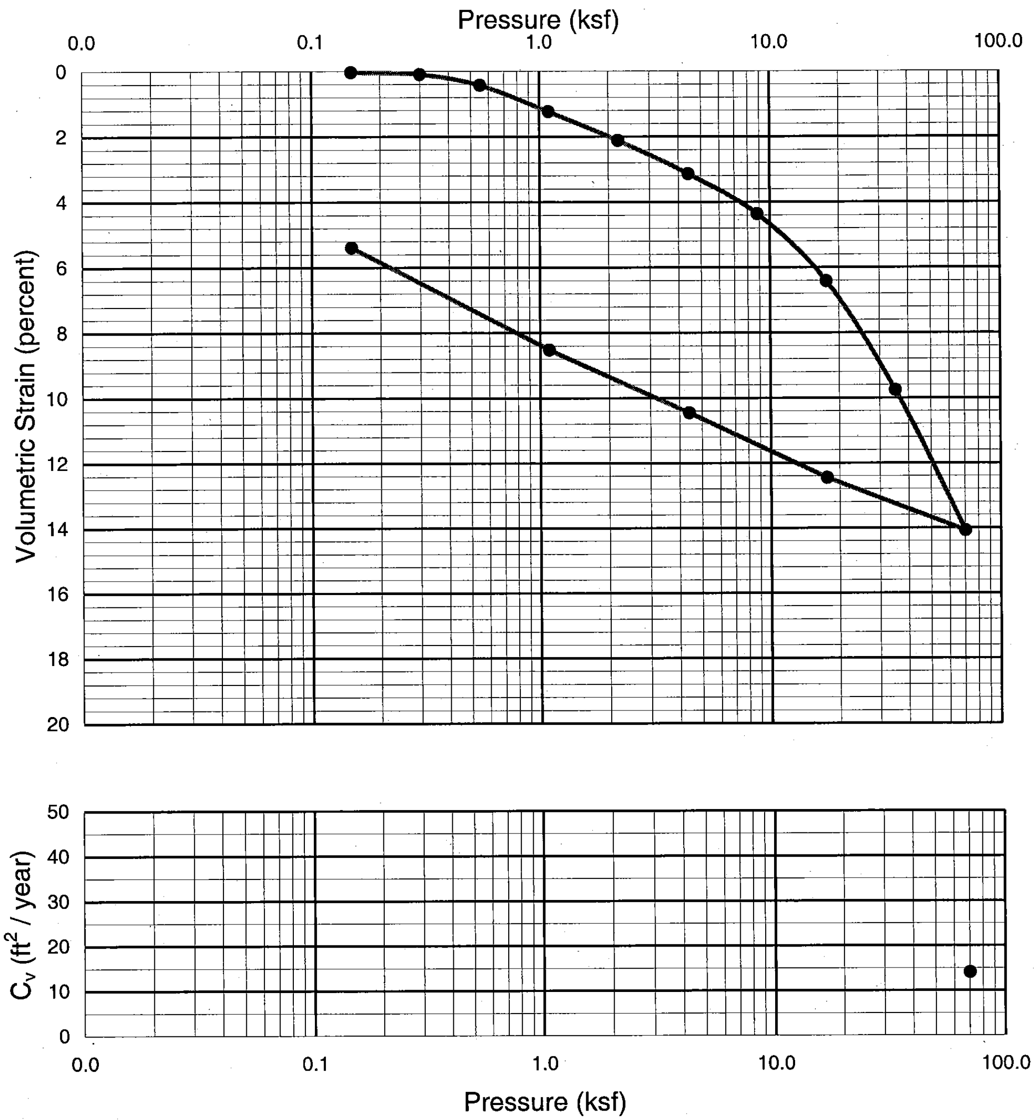
CONSOLIDATION TEST REPORT

Treadwell&Rollo

Date 01/23/07	Project No. 4467.01	Figure B-1



Sampler Type: Sprague & Henwood		Condition	Before Test		After Test		
Diameter (in) 2.41	Height (in) 1.00	Water Content	w_o	31.4 %	w_f	30.2 %	
Overburden Pressure, p_o 2,000 psf		Void Ratio	e_o	0.89	e_f	0.83	
Preconsol. Pressure, p_c 7,800 psf		Saturation	S_o	96.6 %	S_f	100 %	
Compression Ratio, $C_{\varepsilon c}$ 0.14		Dry Density	γ_d	91 pcf	γ_d	94 pcf	
LL --	PL --	PI --			G_s 2.8		
Classification CLAY (CH), light olive-brown		Source B-5 at 25 feet					

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CONSOLIDATION TEST REPORT

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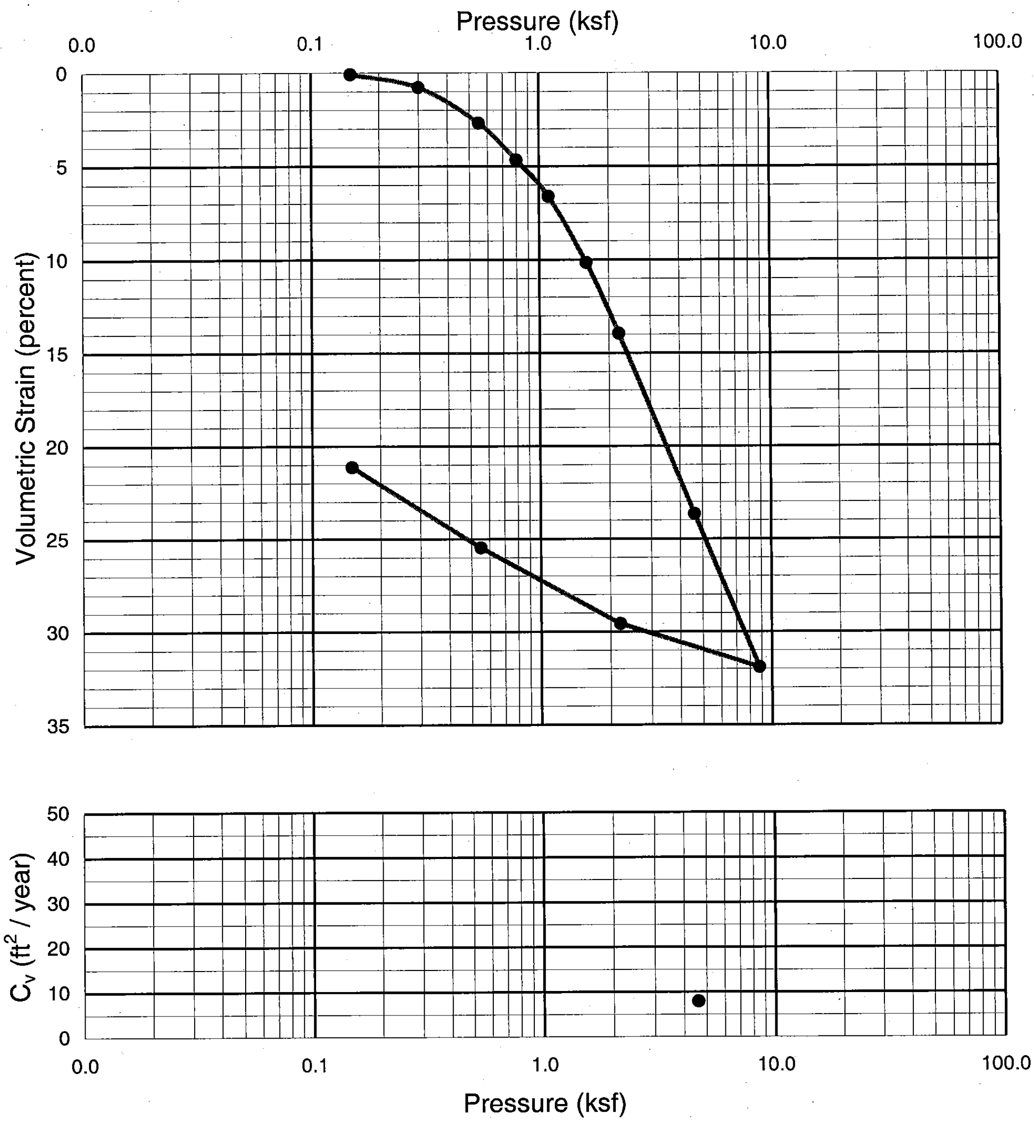
Date 01/23/07 | Project No. 4467.01 | Figure B-2



Sampler Type: Sprague & Henwood			Condition	Before Test		After Test		
Diameter (in) 2.41	Height (in) 1.00		Water Content	w_o	115.2 %	w_f	86.1 %	
Overburden Pressure, p_o	840	psf	Void Ratio	e_o	3.20	e_f	2.32	
Preconsol. Pressure, p_c	840	psf	Saturation	S_o	97.3 %	S_f	100 %	
Compression Ratio, $C_{\varepsilon c}$	0.14		Dry Density	γ_d	40 pcf	γ_d	51 pcf	
LL --	PL --		PI --		G_s 2.7			
Classification CLAY (CH), dark gray			Source B-6 at 14 feet					

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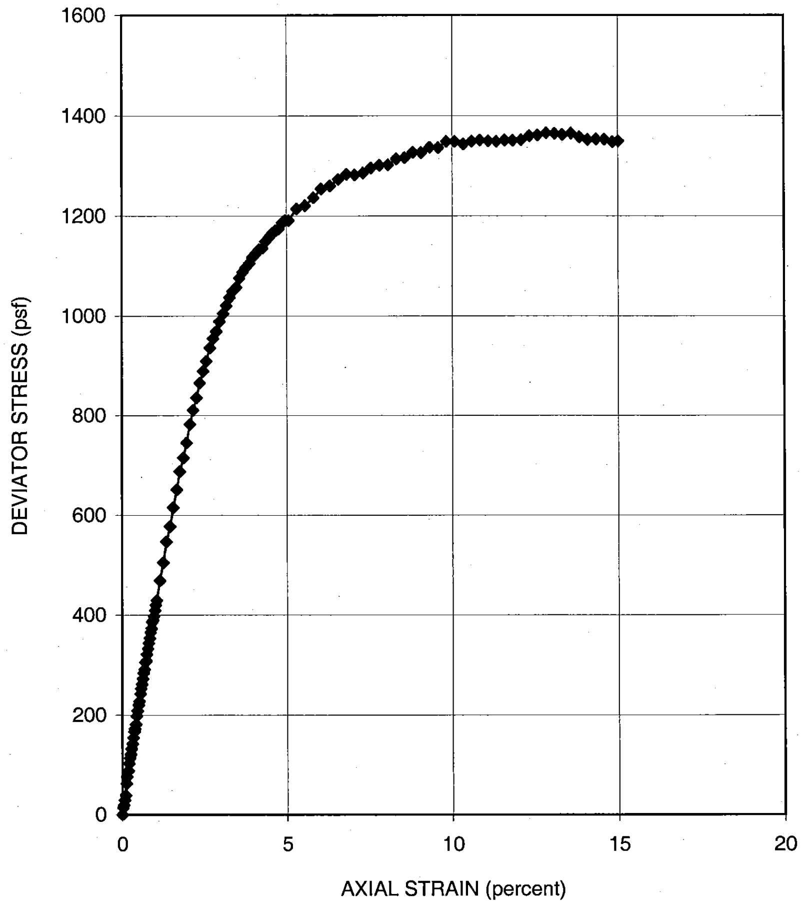
CONSOLIDATION TEST REPORT

Treadwell&Rollo

Date	01/23/07	Project No.	4467.01	Figure	B-3



SAMPLER TYPE	Shelby Tube		SHEAR STRENGTH	680	psf
DIAMETER (in.) 2.9	HEIGHT (in.) 6.0		STRAIN AT FAILURE	13.6	%
MOISTURE CONTENT	60.8	%	CONFINING PRESSURE	1,500	psf
DRY DENSITY	61	pcf	STRAIN RATE	1.00	% / min
DESCRIPTION	CLAY (CH), dark gray			SOURCE	B-3 at 14 feet

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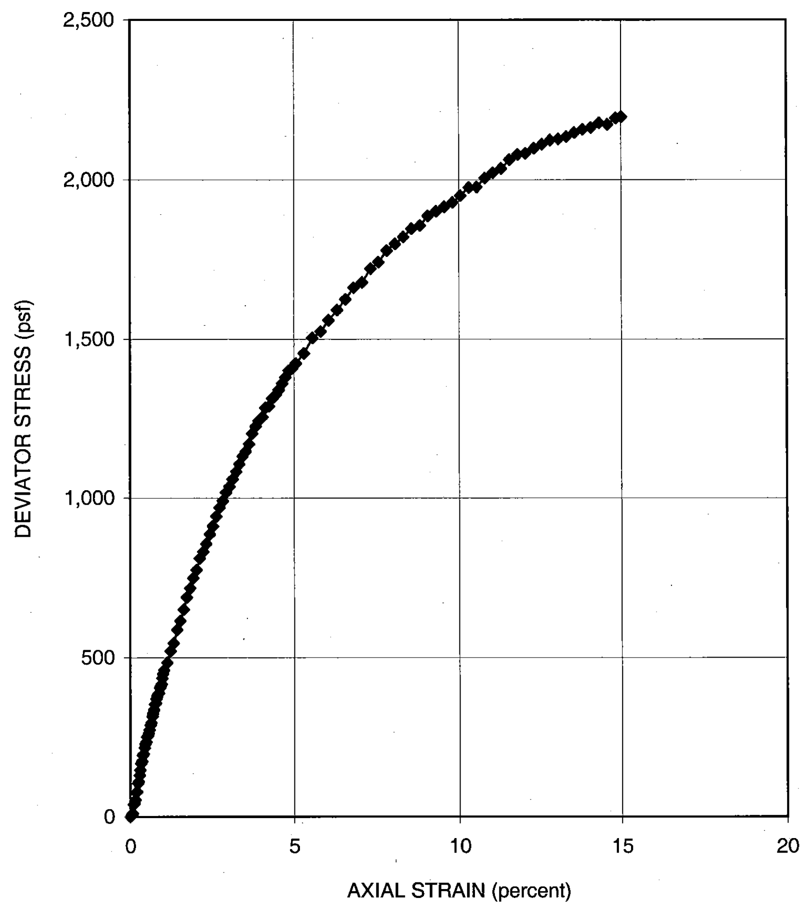
UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 01/23/07 | Project No. 4467.01 | Figure B-4



SAMPLER TYPE	Sprague & Henwood			SHEAR STRENGTH	1,100	psf
DIAMETER (in.)	2.4	HEIGHT (in.)	5.0	STRAIN AT FAILURE	15.0	%
MOISTURE CONTENT		22.9	%	CONFINING PRESSURE	2,000	psf
DRY DENSITY		104	pcf	STRAIN RATE	1.00	% / min
DESCRIPTION	CLAY (CH), dark gray				SOURCE	B-3 at 22 feet

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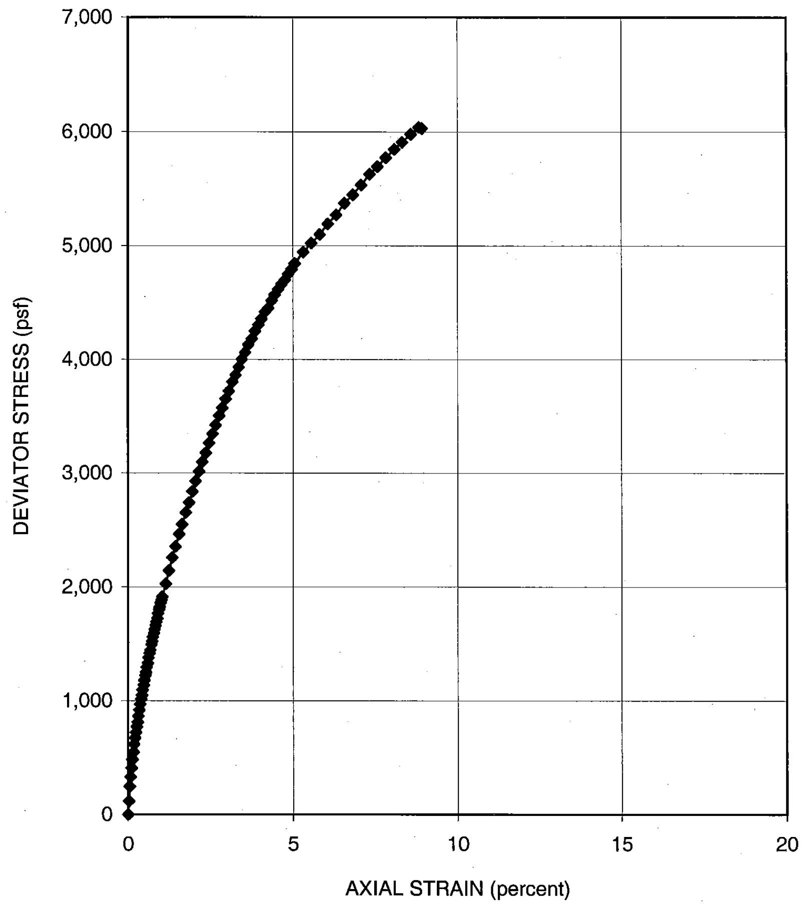
UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 01/23/07 | Project No. 4467.01 | Figure B-5



SAMPLER TYPE	Sprague & Henwood			SHEAR STRENGTH	3,020	psf
DIAMETER (in.)	2.4	HEIGHT (in.)	5.0	STRAIN AT FAILURE	8.8	%
MOISTURE CONTENT		24.9	%	CONFINING PRESSURE	2,400	psf
DRY DENSITY		102	pcf	STRAIN RATE	0.99	% / min
DESCRIPTION	CLAY (CH), light olive-brown and light orange-brown with dark gray mottling			SOURCE	B-3 at 30 feet	

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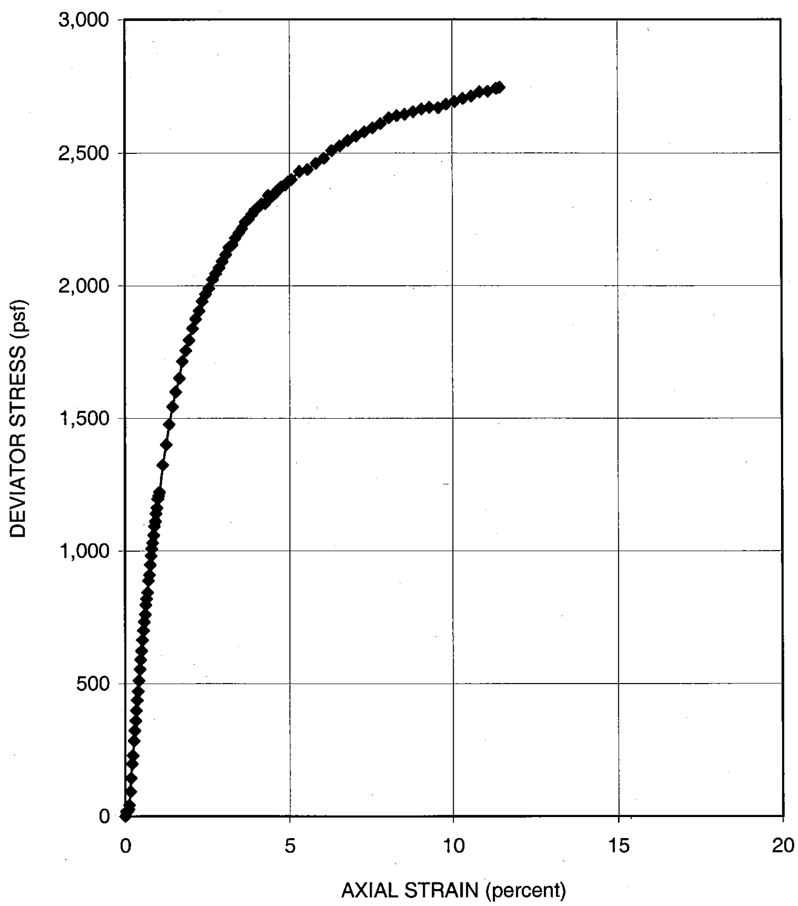
UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 01/23/07 | Project No. 4467.01 | Figure B-6



SAMPLER TYPE	Sprague & Henwood		SHEAR STRENGTH	1,370	psf
DIAMETER (in.) 2.4	HEIGHT (in.) 5.1		STRAIN AT FAILURE	11.4	%
MOISTURE CONTENT	29.0	%	CONFINING PRESSURE	600	psf
DRY DENSITY	93	pcf	STRAIN RATE	0.99	% / min
DESCRIPTION	CLAY (CH), dark gray			SOURCE	B-4 at 4.5 feet

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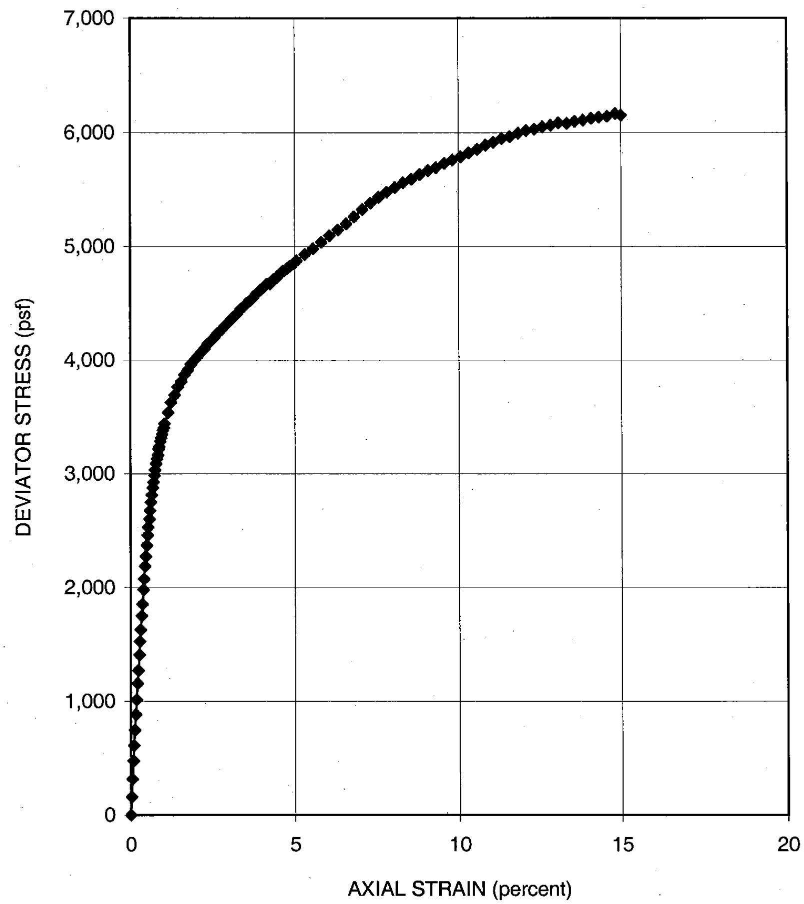
UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 01/23/07 | Project No. 4467.01 | Figure B-7



SAMPLER TYPE	Sprague & Henwood		SHEAR STRENGTH	3,080	psf
DIAMETER (in.) 2.4	HEIGHT (in.) 5.0		STRAIN AT FAILURE	14.8	%
MOISTURE CONTENT	32.2	%	CONFINING PRESSURE	3,000	psf
DRY DENSITY	90	pcf	STRAIN RATE	0.99	% / min
DESCRIPTION	CLAY (CL), light brown and red-brown			SOURCE	B-5 at 40 feet

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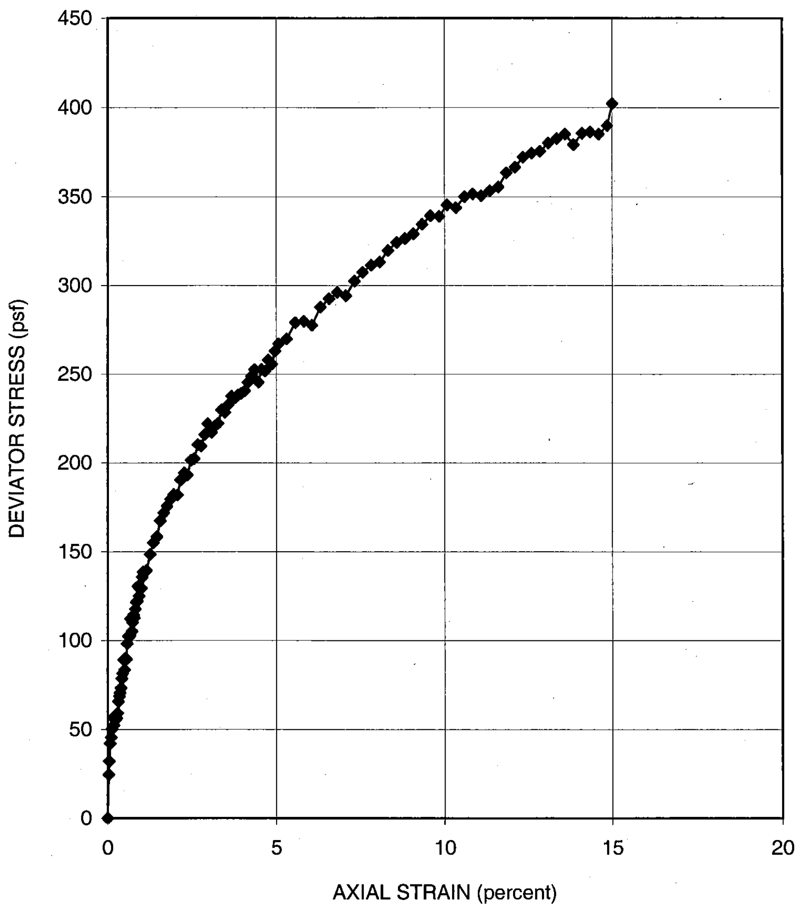
UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 01/23/07 | Project No. 4467.01 | Figure B-8



SAMPLER TYPE Shelby Tube			SHEAR STRENGTH	200	psf
DIAMETER (in.) 2.9	HEIGHT (in.) 6.0		STRAIN AT FAILURE	15.0	%
MOISTURE CONTENT	58.1	%	CONFINING PRESSURE	1,500	psf
DRY DENSITY	61	pcf	STRAIN RATE	1.00	% / min
DESCRIPTION CLAY (CH), dark gray				SOURCE	B-6 at 14 feet

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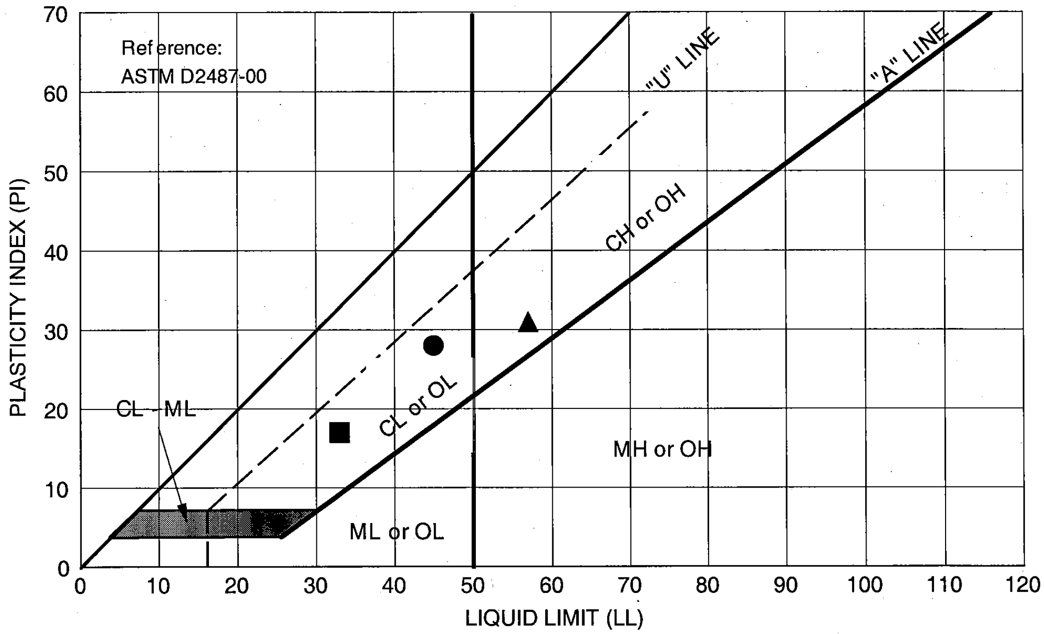
UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 01/23/07 | Project No. 4467.01 | Figure B-9



Symbol	Source	Description and Classification	Natural M.C. (%)	Liquid Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
●	B-1 at 1 foot	CLAY with SAND (CL), dark-brown	--	45	28	--
▲	B-1 at 6 feet	SANDY CLAY (CH), yellow-brown	32.6	57	31	--
■	B-5 at 1.5 feet	SANDY CLAY (CL), yellow-brown	14.7	33	17	--

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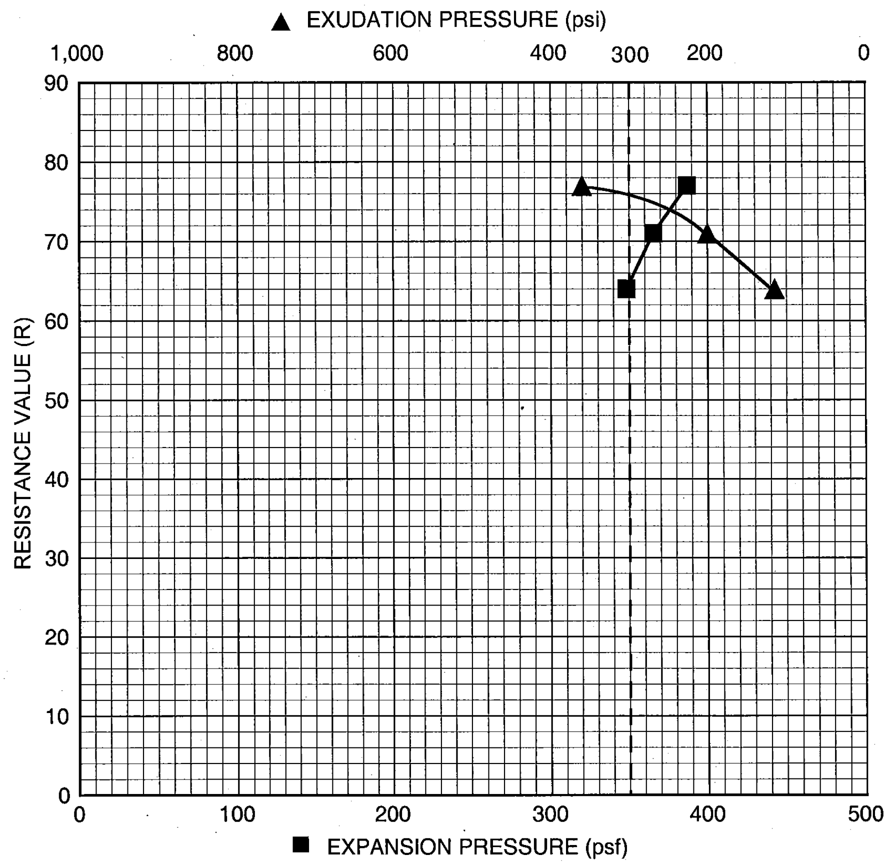
PLASTICITY CHART

Date 10/02/06 | Project No. 4467.01 | Figure B-10



Specimen ID:	A	B	C	D
Water Content (%)	9.1	8.2	10.9	
Dry Density (pcf)	114.3	112.0	116.5	
Exudation Pressure (psi)	360	200	115	
Expansion Pressure (psf)	387	365.5	348.3	
Resistance Value (R)	77	71	64	

Sample Source	Sample Description	Sand Equivalent	Expansion Pressure	R value
S-1 at 1.5 to 3.5 feet	CLAYEY SAND with GRAVEL (SC), brown	--	380 psf	76

NAPA PIPE FACILITY
1025 KAISER ROAD
Napa, California

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RESISTANCE VALUE TEST DATA

Date 10/02/06 | Project No. 4467.01 | Figure B-11

ADDITIONAL GEOTECHNICAL INVESTIGATION

Exhibit O.1 - Additional Geotechnical Investigation, prepared by Treadwell & Rollo, dated May 21, 2007

Treadwell&Rollo

21 May 2007
Project 4467.02

Mr. Caspar Mol
Napa Redevelopment Partners
The Hearst Building
5 Third Street, Suite 1014
San Francisco, California 94103

Subject: Additional Geotechnical Investigation
Napa Pipe Facility Site
1025 Kaiser Road
Napa, California

Dear Mr. Mol:

This letter report presents the results of our additional geotechnical investigation at the Napa Pipe facility site at 1025 Kaiser Road in Napa, California. This investigation was performed in accordance with our proposal dated 20 February 2007. We previously performed a geotechnical feasibility study for the site and presented our results in a report dated 23 January 2007.

The objective of this additional geotechnical investigation was to perform a feasibility-level evaluation of the liquefaction potential of areas of the site adjacent to the Napa River, in response to review comments by the EIR consultant for the project. The review comments included:

1. Recommendations for two additional borings drilled adjacent to the Napa River to at least 50 feet below the ground surface (bgs) to obtain subsurface information for liquefaction and lateral spreading analysis.

2. Evaluation of potential for liquefaction and lateral spreading hazard and provide a discussion of mitigation measures that could be used, where applicable.

In response to the review comments, we drilled two additional borings adjacent to the Napa River to obtain subsurface information and performed laboratory tests on selected soil samples. Based on the results of the additional soil borings and laboratory tests, we performed engineering analyses to evaluate the potential for liquefaction at the site and liquefaction-induced hazards, including lateral spreading. Results of our additional geotechnical investigation are presented in this letter.

PROJECT DESCRIPTION

The site encompasses approximately 152 acres and is bound by the Napa River to the west, Kaiser Road to the north, Syar Industrial Way to the east, and open fields to the south, as shown on Figure 1. It is approximately rectangular in shape measuring about 3,800 feet in the north-south direction and 1,800 feet in the east-west direction. Several industrial buildings, warehouses, various small structures, concrete and asphalt pavements and wetlands occupy the site. The site is generally flat with elevations ranging from approximately 6 to 9 feet,[1] with the exception of the wetland at the southwest corner of the site, where the general elevation ranges from 1 to 2 feet. An existing Southern Pacific Railroad track runs north-south within the site and divides the site approximately in half.

1 All elevations reference NGVD Mean Sea Level Datum of 1929.

ENVIRONMENTAL AND GEOTECHNICAL CONSULTANTS
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Mr. Caspar Mol
Napa Redevelopment Partners
21 May 2007
Page 2

We understand the proposed development will include apartment, condominium, and senior housing facilities as well as offices, hotel, R&D space, and light industrial. The proposed structures are three to four stories high, but may be up to seven stories tall. Furthermore, plans are to also construct some up to three-story tilt-up structures and place up to four feet of fill to raise the general grade level of the site to approximately elevations of 9 to 10 feet. A vehicular bridge is also proposed at the southern property line.

FIELD INVESTIGATION AND LABORATORY TESTING

We further explored subsurface conditions at the site by drilling two test borings, designated B-7 and B-8. The approximate locations of the borings are shown on Figure 1. Prior to performing our field investigation, we obtained a drilling permit from the Napa County, notified Underground Services Alert, and cleared the boring locations of underground utilities using an independent utility locating contractor.

The two test borings were drilled on 22 March 2007 by Pitcher Drilling Company, of East Palo Alto, California. Borings B-7 and B-8 were drilled to depths of about 60 and 49.5 feet bgs, respectively, using a truck-mounted, rotary-wash drill rig. Our field engineers logged the borings and obtained samples of the material encountered for visual classification and laboratory testing. Upon completion, the borings were backfilled with cement grout in accordance with Napa County requirements. The logs of the borings are presented on Figures A-1 through A-2 in Appendix A. The soil is classified in accordance with the chart shown on Figure A-3.

Soil samples were obtained using three different types of samplers: two split-barrel samplers and one thin-walled sampler. The sampler types are as follows:

- Sprague and Henwood (S&H) split-barrel sampler with a 3.0-inch outside diameter and 2.5-inch inside diameter, lined with brass tubes with an inside diameter of 2.43 inches
- Standard Penetration Test (SPT) sampler with a 2.0-inch outside and 1.5-inch inside diameter, without liners
- Shelby tubes with a 3.0-inch outside diameter and 2.875-inch inside diameter.

The sampler types were chosen on the basis of soil type and desired sample quality for laboratory testing. In general, the S&H sampler was used to obtain samples in medium stiff to very stiff cohesive soil and the SPT sampler was used to evaluate the relative density of sandy soil. The Shelby tube piston sampler was used to obtain relatively undisturbed samples of the soft to medium stiff cohesive soil.

The S&H and SPT samplers were driven with a 140-pound automatic hammer falling about 30 inches. The blow counts required to drive the SPT and S&H samplers the final 12 inches of an 18-inch drive were corrected using factors of 1.1 and 0.7, respectively, to approximate SPT-N blow counts. The corrected SPT-N blow counts are shown on the boring logs. In addition, the hydraulic pressures used to advance the 36-inch-long Shelby tubes into the soil, measured in pounds per square inch (psi), are shown on the boring logs.

The soil samples recovered from the field exploration program were re-examined to confirm the field classifications and to select samples for geotechnical laboratory testing. Soil samples were tested to

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measure consolidation parameters and Atterberg limits for use in the liquefaction analyses. The laboratory test results are presented on the boring logs and in Appendix B.

SUBSURFACE CONDITIONS

Subsurface information from this investigation indicates that at borings B-7 and B-8, the ground surface is covered with approximately 4 to 5 inches of asphalt concrete pavement. In boring B-7, the pavement section is underlain by approximately 1.5 feet of gravelly fill. In boring B-8, the pavement section is underlain by approximately 7 feet of loose to medium dense clayey sand.

In both borings, the fill and clayey sand are underlain by marine deposit comprised of very soft to stiff clay and silt with organics that varies in thickness from 22.5 feet thick in B-7 and 26.5 feet thick in B-8. A one-foot-thick layer of peat was encountered in boring B-8 at a depth of 13 feet bgs. Where tested, the marine deposit appears to be normally to slightly overconsolidated.[2] The fill and marine deposits are generally underlain by a deep alluvium deposit, which consists of layers of dense clayey sand, very stiff sandy clay with gravel, very dense sandy gravel, and medium stiff to very stiff clay and silt to the maximum explored depth. Groundwater was measured in each boring during drilling, prior to the use of rotary wash drilling fluid. Groundwater was encountered at a depth of about 8 feet bgs in boring B-7 and at a depth of about 5 feet bgs in boring B-8.

DISCUSSION AND CONCLUSIONS

The results of our additional subsurface investigation and laboratory testing were used to further evaluate the liquefaction potential at the location of B-7 and B-8 borings. Liquefaction is a phenomenon in which saturated soil temporarily loses strength from the build up of excess pore water pressure, especially during earthquake-induced cyclic loading. Soil susceptible to liquefaction includes loose to medium dense sand and gravel, low-plasticity silt, and some low-plasticity clay deposits.

We judge the medium dense clayey sand encountered in boring B-8 between depths of 5 and 7.5 feet bgs is susceptible to liquefaction during a major earthquake event. The soil encountered in boring B-8 below a depth of 7.5 feet bgs and in boring B-7 has sufficient fines content and plasticity and are not susceptible to liquefaction.[3] In addition, several feet of medium dense sand with varying amounts of clay and silt were encountered in borings B-1, B-3, and B-5 beneath the groundwater that is also susceptible to liquefaction during a major earthquake event. We estimate the ground surface will settle about 1/2 inch due to liquefaction of these layers.

Considering that the liquefiable soil encountered in boring B-8 (the clayey sand between depths 5 and 7.5 feet bgs) appears to be discontinuous, we preliminarily conclude the potential for liquefaction-induced lateral spreading appears not to be widespread and not to have detrimental effects on the stability of the Napa River shoreline in the area investigated as part of this study. However, detailed studies should be

---

[2] A normally consolidated clay has completed consolidation under the existing pressure; and an overconsolidated clay has experienced a pressure greater than its current overburden pressure.

[3] Seed, R.B., et al. (2003). "Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework." 26th Annual ASCE Los Angeles Geotechnical Spring Seminar, Keynote Presentation, H.M.S. Queen Mary, Long Beach, California, 30 April.

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Mr. Caspar Mol
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Page 4

performed as part of the final geotechnical investigation to further evaluate liquefaction and lateral spreading potential at the project site.

Based on the results of this additional geotechnical investigation, we conclude the preliminary recommendations for building and bridge foundations and seismic design criteria presented in our report dated 23 January 2007 is still applicable to the project for feasibility evaluation. During final design, a detailed foundation investigation should be performed for each new project. The investigation should include test borings, cone penetration tests (CPTs), laboratory tests, as appropriate, to develop foundation design criteria.

We trust this letter provides the information you need. If you have any questions, please call.

Sincerely yours,
TREADWELL & ROLLO, INC.

REGISTERED PROFESSIONAL ENGINEER
HUI JUN LIANG
GE2663
Exp. 6/30/2008
GEOTECHNICAL
STATE OF CALIFORNIA

Linda H. Liang
Geotechnical Engineer

Ramin Golesorkhi
Geotechnical Engineer

44670201.OAK

Attachments: Figure 1 – Site Plan
Appendix A – Boring Logs
Appendix B – Laboratory Test Results

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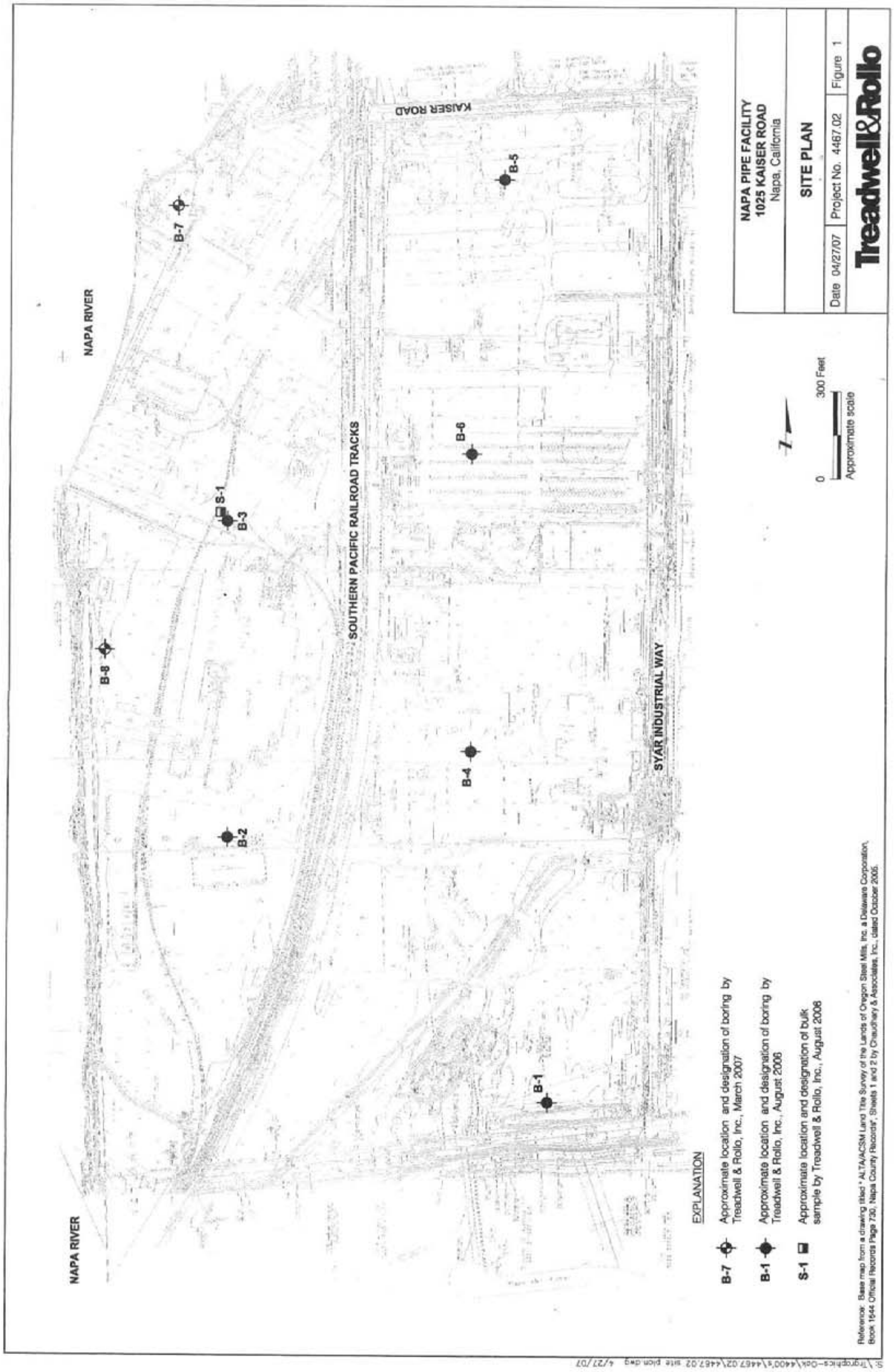
FIGURE


NAPA RIVER
NAPA RIVER
KAISER ROAD
SOUTHERN PACIFIC RAILROAD TRACKS
SYAR INDUSTRIAL WAY
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
S-1
0
300 Feet
Approximate scale
EXPLANATION
B-7 Approximate location and designation of boring by Treadwell & Rollo, Inc., March 2007
B-1 Approximate location and designation of boring by Treadwell & Rollo, Inc., August 2006
S-1 Approximate location and designation of bulk sample by Treadwell & Rollo, Inc., August 2006
NAPA PIPE FACILITY
1025 KAISER ROAD
Napa, California
SITE PLAN
Date 04/27/07
Project No. 4467.02
Figure 1
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APPENDIX A
Boring Logs

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-7

PAGE 1 OF 2

Boring location: See Site Plan, Figure 2
Date started: 3/22/07 | Date finished: 3/22/07
Drilling method: Rotary Wash
Hammer weight/drop: 140 lbs./30 inches | Hammer type: Automatic
Sampler: Sprague & Henwood (S&H), Shelby Tube (ST)
Logged by: A. Scavullo

LABORATORY TEST DATA

DEPTH (feet)	Sampler Type	SPT N-Value	LITHOLOGY	MATERIAL DESCRIPTION		Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–2			GP	4 inches of asphalt concrete Gravelly fill	FILL						
2–11			CH	CLAY (CH) dark gray, very soft, wet, with organics and fine gravel	MARINE DEPOSIT						
4–5	ST	<25 psi									
6						PP		<500			
8				⊻ (3/22/07) Consolidation Test, see Figure B-2						51.3	69
9–10	ST	<25 psi				Tv		340			
11–18			MH	SILT (MH) dark gray, very soft, wet, with organics LL = 51, PI = 21, see Figure B-1							
14–15	ST	<25 psi				PP		<500			
18–25			CH	CLAY (CH) dark gray, medium stiff to stiff, wet, with organics, trace sand							
21–22	ST	25 psi				PP Tv		1,250 850			
25–30			CL	CLAY with SAND and SILT (CL) dark gray, medium stiff to stiff, wet, little organics							
28–29	ST	150 psi				PP Tv		1,500 850			

TEST GEOTECH LOG 446702.GPJ TR.GDT 5/2/07

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Project No.: 4467.02 | Figure: A-1a

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-7

PAGE 2 OF 2

DEPTH (feet)	Sampler Type	Sample	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31				CL	CLAY with SAND and SILT (CL) (continued)						
32				CH	CLAY (CH) gray-brown, stiff to very stiff, wet						
34–35	S&H	■	14			PP Tv		2,000 1,700			
39				CL	CLAY (CL) gray and olive-brown, stiff, wet						
40–41	S&H	■	15								
42				ML	SILT (ML) gray and olive-brown, medium stiff to stiff, wet						
45					LL = 46, PI = 17, see Figure B-1						
45–46	S&H	■	7								
50–51	S&H	■	13								
56.5				GP	SANDY GRAVEL (GP) gray, very dense, wet, sub-angular gravels						
59–60	S&H	■	58								
60											

Boring terminated at a depth of 60 feet bgs.
Boring backfilled with cement grout.
Groundwater encountered at a depth of about 8 feet bgs during drilling.
PP = pocket penetrometer.
Tv = torvane.

[1] S&H blowcounts converted to equivalent SPT N-values using a factor of 0.7.

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Project No.: 4467.02 | Figure: A-1b

TEST GEOTECH LOG 446702.GPJ TR.GDT 5/2/07

PROJECT:	NAPA PIPE FACILITY 1025 KAISER ROAD Napa, California	Log of Boring B-8 PAGE 1 OF 2

Boring location:	See Site Plan, Figure 2
Date started:	3/22/07
Date finished:	3/22/07
Drilling method:	Rotary Wash
Hammer weight/drop:	140 lbs./30 inches
Hammer type:	Automatic
Sampler:	Sprague & Henwood (S&H), Standard Penetration Test (SPT), Shelby Tube (ST)
Logged by:	A. Scavullo

DEPTH (feet)	Sampler Type	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0				5 inches of asphalt concrete						
0–7.5			SC	CLAYEY SAND (SC) gray, loose, wet						
4–5				medium dense ▽ (3/22/07)						
5–8	ST	500 psi								
7.5–13			MH	SILT (MH) dark gray, very soft, wet, with organics						
10–13	ST	<25 psi		LL = 66, PI = 27, see Figure B-1	Tv		340			
13–14			PT	PEAT (PT) in drill cuttings						
14–30			CH	CLAY (CH) gray, very soft to medium stiff, wet, with organics						
17–20	ST	<25 psi		Consolidation Test, see Figure B-3 LL = 63, PI = 32, see Figure B-1					56.8	66
25–28	ST	25 psi		dark gray, with silt						

MARINE DEPOSIT (approx. 7.5 to 30 feet)

TEST GEOTECH LOG 446702.GPJ TR.GDT 5/2/07

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Project No.: 4467.02

Figure: A-2a

PROJECT: **NAPA PIPE FACILITY**
1025 KAISER ROAD
Napa, California

Log of Boring B-8

PAGE 2 OF 2

DEPTH (feet)	SAMPLES: Sampler Type	SAMPLES: Sample	SAMPLES: SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	LABORATORY TEST DATA: Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
30–34				CH	CLAY (CH) (continued) — MARINE DEPOSIT						
34				CL	SANDY CLAY with GRAVEL (CL) yellow-brown, very stiff, wet						
35–36	S&H		26	CL							
38				CL	grades more sandy						
39				SC	CLAYEY SAND (SC) red-yellow, dense, wet						
42–43	S&H		39	SC							
48–49	SPT		41	SC	yellow-brown						
49.5–60											

Boring terminated at a depth of 49.5 feet bgs.
Boring backfilled with cement grout.
Groundwater encountered at a depth of about 5 feet bgs during drilling.
Tv = torvane.

[1] S&H and SPT blowcounts converted to equivalent SPT N-values using factors of 0.7 and 1.1, respectively.

TEST GEOTECH LOG 446702.GPJ TR.GDT 5/2/07

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Project No.:	Figure:
4467.02	A-2b

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		Symbols	Typical Names
Coarse-Grained Soils (more than half of soil > no. 200 sieve size)	Gravels (More than half of coarse fraction > no. 4 sieve size)	GW	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	SW	Well-graded sands or gravelly sands, little or no fines
		SP	Poorly-graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
Fine -Grained Soils (more than half of soil < no. 200 sieve size)	Silts and Clays LL = < 50	ML	Inorganic silts and clayey silts of low plasticity, sandy silts, gravelly silts
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean c lays
		OL	Organic silts and organic silt-clays of low plasticity
	Silts and Clays LL = > 50	MH	Inorganic silts of high plasticity
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic silts and clays of high plasticity
Highly Organic Soils		PT	Peat and other highly organic soils

GRAIN SIZE CHART

Classification	Range of Grain Sizes: U.S. Standard Sieve Size	Range of Grain Sizes: Grain Size in Millimeters
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 4.76
coarse	3" to 3/4"	76.2 to 19.1
fine	3/4" to No. 4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.074
coarse	No. 4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.074
Silt and Clay	Below No. 200	Below 0.074

Unstabilized groundwater level

Stabilized groundwater level

SAMPLE DESIGNATIONS/SYMBOLS

- Sample taken with split-barrel sampler other than Standard Penetration Test sampler. Darkened area indicates soil recovered
- Classification sample taken with Standard Penetration Test sampler
- Undisturbed sample taken with thin-walled tube
- Disturbed sample
- Sampling attempted with no recovery
- Core sample
- Analytical laboratory sample
- Sample taken with Direct Push sampler

SAMPLER TYPE

C	Core barrel
CA	California split-barrel sampler with 2.5-inch outside diameter and a 1.93-inch inside diameter
D&M	Dames & Moore piston sampler using 2.5-inch outside diameter, thin-walled tube
O	Osterberg piston sampler using 3.0-inch outside diameter, thin-walled Shelby tube
PT	Pitcher tube sampler using 3.0-inch outside diameter, thin-walled Shelby tube
S&H	Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter
SPT	Standard Penetration Test (SPT) split-barrel sampler with a 2.0-inch outside diameter and a 1.5-inch inside diameter
ST	Shelby Tube (3.0-inch outside diameter, thin-walled tube) advanced with hydraulic pressure

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CLASSIFICATION CHART

Date 04/24/07 | Project No. 4467.02 | Figure A-3

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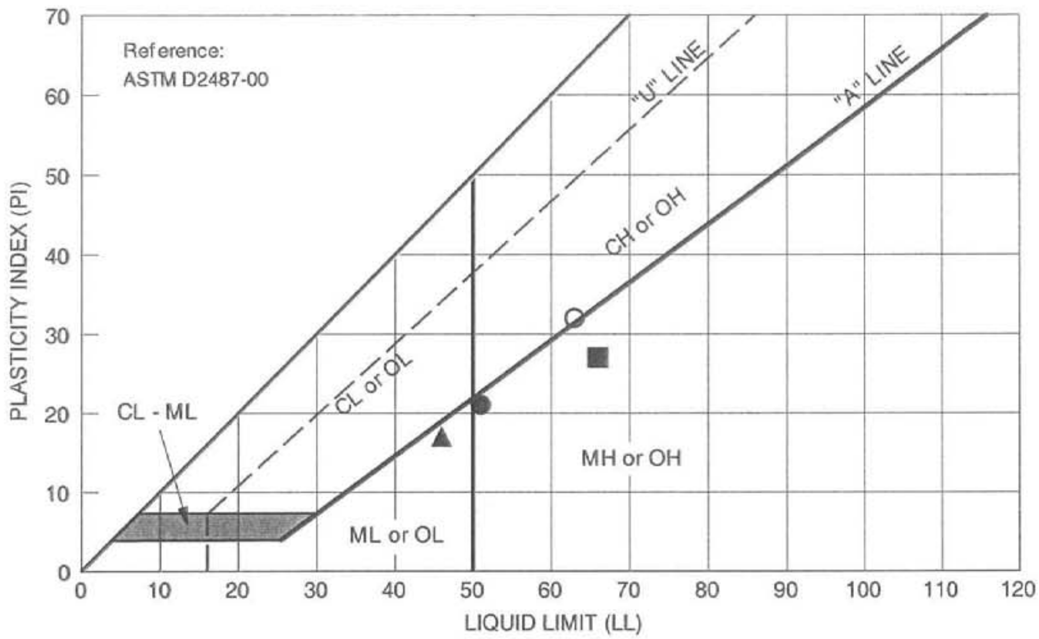
APPENDIX B
Laboratory Test Results



Symbol	Source	Description and Classification	Natural M.C. (%)	Liquid Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
●	B-7 at 13 feet	SILT (MH), dark gray	--	51	21	--
▲	B-7 at 45 feet	SILT (ML), gray and olive-brown	--	46	17	--
■	B-8 at 10 feet	SILT (MH), dark gray	--	66	27	--
○	B-8 at 17 feet	CLAY (CH), gray	--	63	32	--

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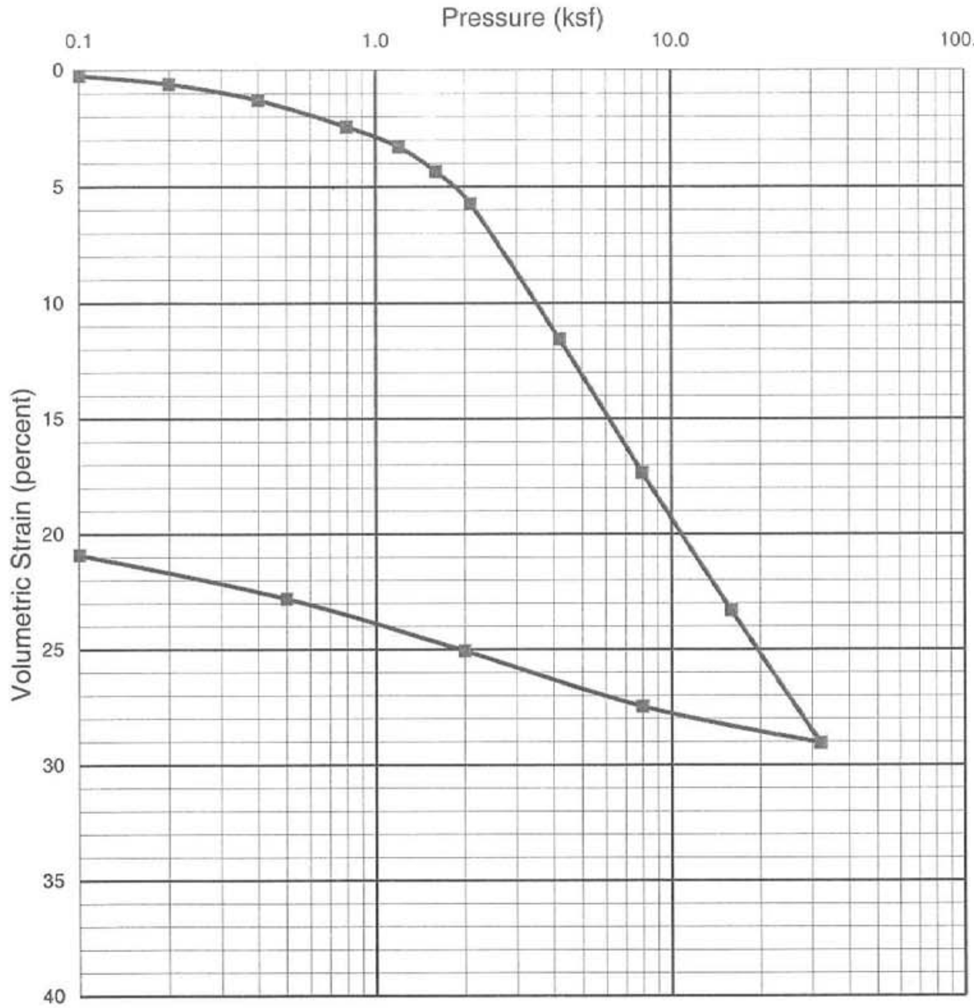
PLASTICITY CHART

Date 04/27/07 | Project No. 4467.01 | Figure B-1



Sampler Type: Shelby Tube				Condition		Before Test		After Test	
Diameter (in)	2.42	Height (in)	1.00	Water Content	w_o	51.3 %	w_f	36.8 %	
Overburden Pressure, p_o	500	psf		Void Ratio	e_o	1.44	e_f	0.93	
Preconsol. Pressure, p_c	1,700	psf		Saturation	S_o	96 %	S_f	106 %	
Compression Ratio, $C_{\varepsilon c}$	0.22			Dry Density	γ_d	69 pcf	γ_d	87 pcf	
LL --		PL --		PI --			G_s	2.70	(assumed)
Classification CLAY (CH), dark gray				Source		B-7 @ 8 feet			

NAPA PIPE FACILITY, 1025 KAISER ROAD
Napa, California

CONSOLIDATION TEST REPORT

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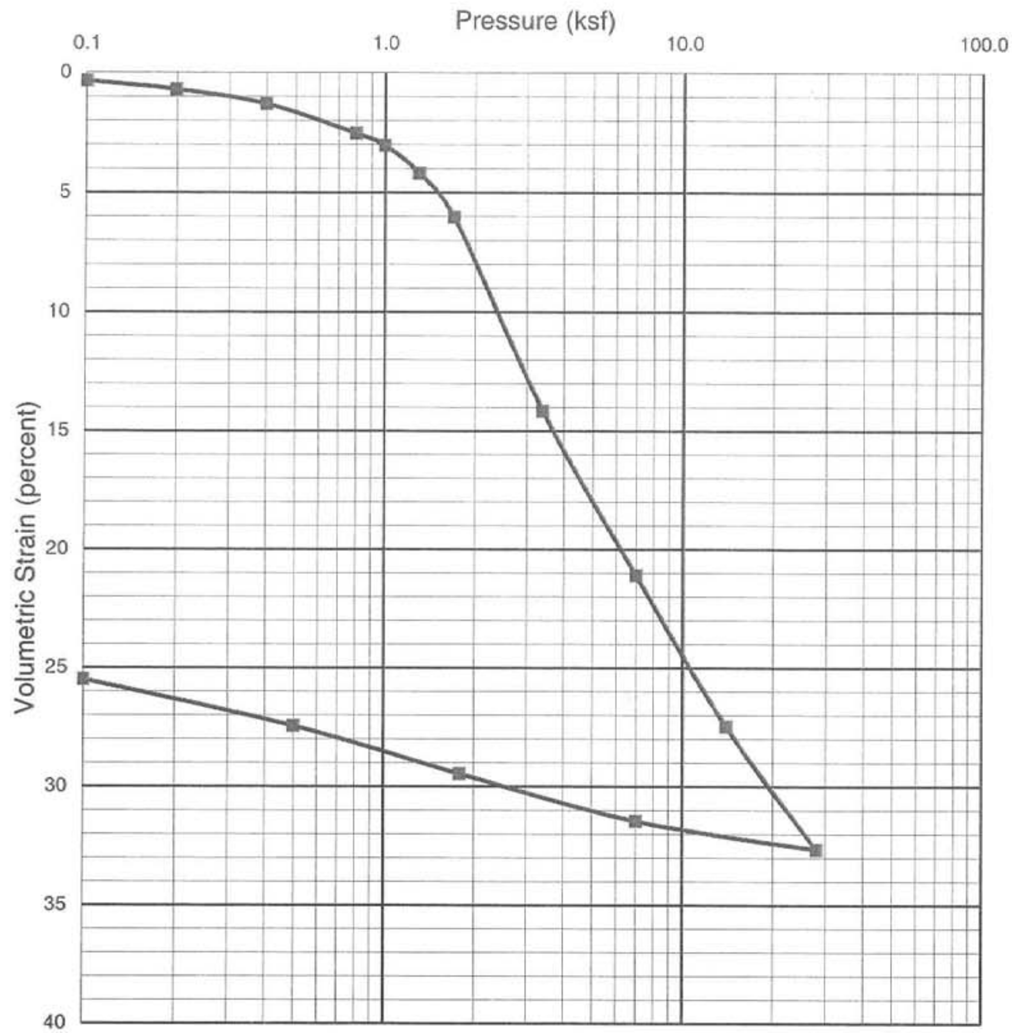
Date 04/27/07 | Project No. 4467.02 | Figure B-2



Sampler Type: Shelby Tube				Condition		Before Test		After Test	
Diameter (in) 2.42	Height (in) 1.00			Water Content	w_o	56.8 %	w_f	35.3 %	
Overburden Pressure, p_o	1,100 psf			Void Ratio	e_o	1.56	e_f	0.90	
Preconsol. Pressure, p_c	1,300 psf			Saturation	S_o	99 %	S_f	105 %	
Compression Ratio, $C_{\varepsilon c}$	0.24			Dry Density	γ_d	66 pcf	γ_d	89 pcf	
LL 63	PL 31			PI 32			G_s 2.70	(assumed)	
Classification CLAY (CH), gray				Source		B-8 @ 17 feet			

NAPA PIPE FACILITY, 1025 KAISER ROAD
Napa, California

CONSOLIDATION TEST REPORT

Treadwell&Rollo

Date 04/27/07 | Project No. 4467.02 | Figure B-3

EXCERPTS FROM HABITAT PRESERVATION AND OPEN SPACE ELEMENTS REPORT

Exhibit P.1 - Excerpts from “Habitat Preservation and Open Space Elements Report,” May 2009

Below are excerpts from Zander and Associates 'Habitat Preservation and Open Space Elements Report' which pertain to landscaped areas adjacent to wetlands.

2.2 Wetland Buffer Zones

A 50 foot buffer zone will be established around all existing jurisdictional waters and wetlands on the project site. A minimum of 10 feet adjacent to the wetland will remain at existing grade and may be improved through removal of existing hardscape or other features associated with development and revegetation. The remaining 40 feet will be filled and contoured to match proposed grades. The first 15 feet of fill area will be contoured at a maximum 4:1 slope and will be planted with appropriate native vegetation. The remaining 25 feet will be contoured at a maximum 3:1 slope. This zone will also be planted with native species and may accommodate pedestrian paths. Appendix C includes typical illustrative cross-sections of the proposed wetland buffer zones. The habitat within these buffer zones will be improved by restoring native soil, removing exotic plants, and planting native vegetation appropriate for the area. A list of native plants suitable for these buffer zones is provided in Appendix B. Specific planting plans will be developed for each zone by a restoration specialist once detailed grading plans are completed for the project areas adjacent to the zone.

A restoration and maintenance program will be developed and implemented for the wetland and buffer areas to remove non-native exotic species such as pepperweed (*Lepidium latifolium*), Pampas grass (*Cortaderia selloana*), and yellow star thistle (*Centaurea solstitialis*).

Removal of non-native exotic species can be done by hand or through application of herbicides. Hand removal is preferable, particularly within 25 feet of the wetland area. In some cases, the entire root system of the plant may need to be removed in order to control the weed and mechanical equipment such as a Bobcat or backhoe may be necessary. Where this equipment is necessary, measures should be implemented to prevent excavated soil from entering the wetland and the soil should be returned to the hole immediately. Plant material removed should be hauled offsite as soon as possible to prevent regeneration. Any necessary application of herbicides must follow all manufacturer specifications and California requirements for application near aquatic systems.

Following are recommended removal strategies for each of the three target species identified above. These removal strategies are intended as an initial attempt to clear out the non-native vegetation but long-term management will be needed to control the reestablishment of these plants in the wetland areas.

> Perennial pepperweed: This plant has a deep, extensive root system with a high reproductive potential that allows it to sprout repeatedly following removal of aboveground growth. Perennial roots must be killed or removed to prevent reinfestation by perennial pepperweed. Strategies to control perennial pepperweed must include removing aboveground growth and perennial roots, preventing seed production, monitoring for perennial pepperweed re-establishment for several years, locating and controlling potential sources of reinfestation (e.g. populations upstream, down the road, next door, etc.), and establishing desirable vegetation. Some researchers suggest that glyphosate (Roundup®) can effectively control perennial pepperweed. It is important to establish native vegetation in areas where perennial pepperweed is removed as soon as possible after removal.

Pampas grass: This weed is very difficult to control because its seeds spread readily via the wind. Continued vigilance will be required to actually control this species but initial mechanical removal will help reduce this effort. If the plants are in flower - large plumes are present – the plumes should be cut from the plant and placed in a plastic bag before the grass clumps are removed. The clumps can either be dug out using a backhoe or pulled using a choker cable and a wench. Once the clumps are uprooted, they should be left upside down with the roots exposed and out of contact with the soil until they die. This step must be included, even if the material is hauled offsite, in order to prevent the spread of pampas grass elsewhere.

Yellow star thistle: Control of yellow star thistle should include, whenever possible, an integration of mechanical, cultural, biological, and chemical techniques. Descriptions of the various techniques that can be used can be found at the following website managed by the University of California, Davis: http://wric.ucdavis.edu/yst/yst.html . A long-term commitment of three to five or more years will be necessary in nearly all cases to deplete the weed seedbank. It will require a significant reduction in the seedbank and an increase in the seedbanks of other desirable competing species before dramatic results can be observed. Regardless of the approach employed, annual monitoring and evaluations should be conducted to determine the adequacy of the management plan. Changes in the management approaches may be necessary to adjust to any unforeseen problems and improve the strategy.

All of the existing wetlands and buffer zones will be designated as permanent open space, restricting future development in these areas (with the exception of pedestrian trails).

2.4.1 River Park

The River Park extends from the dry-docks down to the large wetland at the southernmost portion of the site. It includes a link to the Bay Trail, the Nature Center and an overlook area on a large mound that will be created over the capped landfill in the southern portion of the park. The park will be approximately 50-feet-wide starting from the edge of the existing riparian zone associated with the Napa River and extending inland. Buildings will be set back a minimum of 25 feet from the inland boundary of the park. Cross sections of the proposed park design are provided in Appendix C.

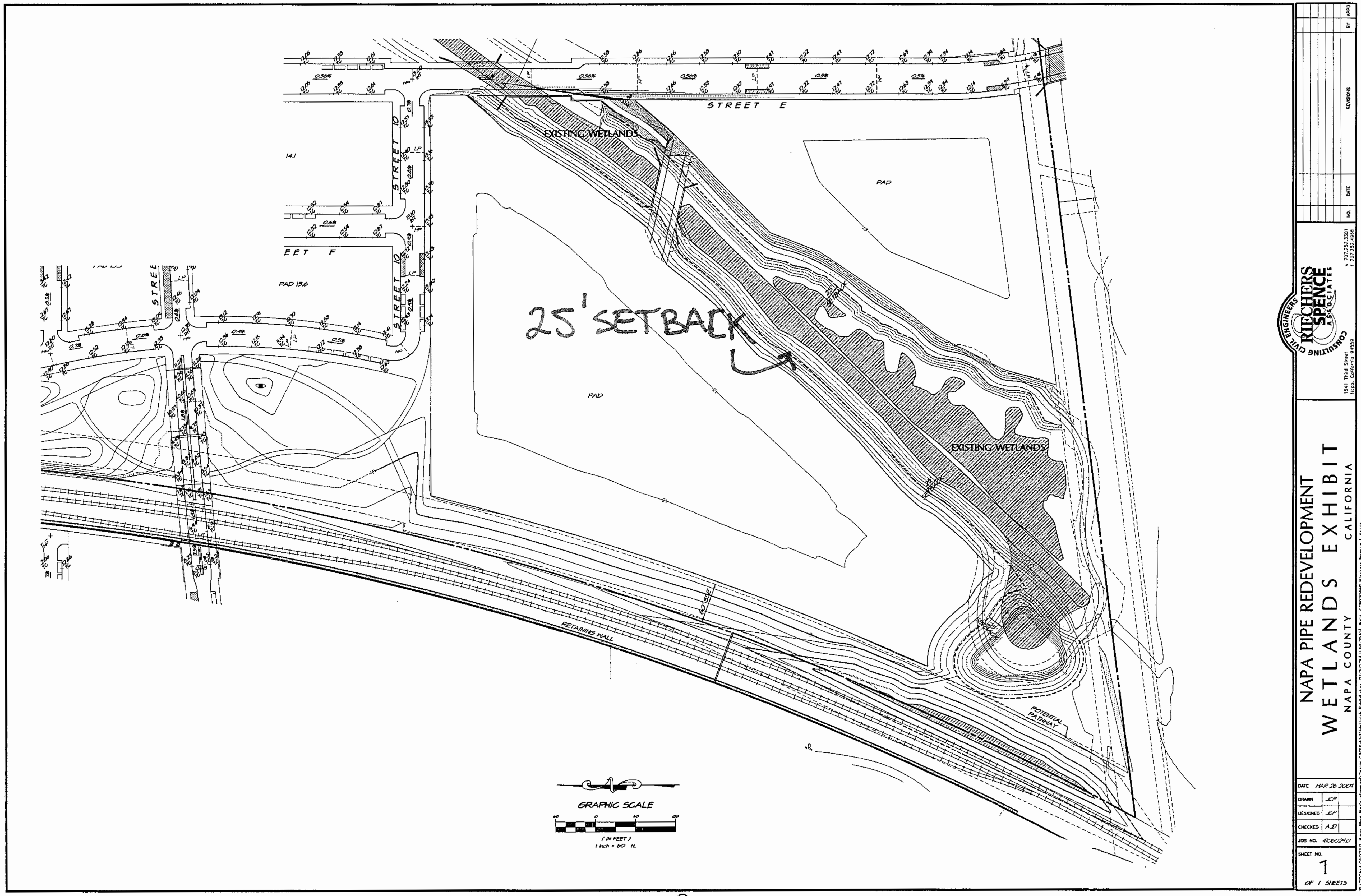
The park will be vegetated with native riparian and woodland plants in the area west of the Bay Trail. The trail will be placed a minimum of 25 feet back from the top-of-bank of the Napa River so there will be a band of native vegetation established along the banks for a distance of approximately 2,000 linear feet. A palette of suggested species is provided in Appendix B. A relatively dense understory of low-growing shrubs will be planted to deter access to the river in this area while maintaining unobstructed views from the trail out over the river. The shrubs plantings will be interspersed with native trees to add structure and diversity to the habitat. The overlook area is intended to be a grassy knoll that will include native grasses such as purple needlegrass (*Nasella pulchra*), California oatgrass (*Danthonia californica*), annual hairgrass (*Deschampsia danthonioides*), and blue wildrye (*Elymus glaucus*). Native wildflowers will also be considered for this area. Suggested plant species are listed in Appendix B.

Installation of the River Park will result in the conversion of existing hardscape to areas vegetated with native tree, shrub and herbaceous species that will improve the habitat for local wildlife by adding vegetative structure (shrubs and trees) and creating refuge, roosting and foraging areas for wildlife.

2.4.2 Railroad Park

The Railroad Park will be situated east of the railroad and will average approximately 90 feet to 200 feet in width. It will include a biorentention swale that will be vegetated with typical wetland plants. Trees will be placed at the edge of the swale and will consist of native riparian and/or upland species as appropriate for the specific habitat. A list of suggested species for each of these areas is provided in Appendix B. A serpentine pedestrian and bicycle path will extend through the length of the park.

Exhibit P.1 - EXCERPTS FROM “HABITAT PRESERVATION AND OPEN SPACE ELEMENTS REPORT,” MAY 2009



EXCERPT FROM CULTURAL RESOURCES SURVEY

Exhibit Q.1 - Excerpt From Cultural Resources Survey

A Cultural Resources Survey of the Napa Pipe Property, 1025 Kaiser Road Napa County, California

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October 20, 2007

ABSTRACT

Tom Origer & Associates conducted a cultural resources survey for the Napa Pipe Project, Napa County, California. The study was requested by Design, Community & Environment, representing the project proponent, Napa Redevelopment Partners. The study area is located in southern Napa County, about three miles south of downtown Napa, on the east shore of the Napa River opposite 'Horseshoe Bend'. It consists of approximately 152 acres of level land, much of which was former river marsh.

This study included archival research at the Northwest Information Center, Sonoma State University (NWIC File No. 06-369), examination of the library and files of Tom Origer & Associates, and field inspection of the project location. Field survey found buildings and structures associated with a shipbuilding operation dating to the late-1930s and 1940s. A primary record was completed for the shipyard. Documentation pertaining to this study is on file at the offices of Tom Origer & Associates (File No. 06-95S).

Synopsis

Project:	Napa Pipe
Location:	1025 Kaiser Road, Napa County
Quadrangle:	Napa 7.5' series
Elevation:	Approximately five to 10 feet
Study Type:	Intensive survey
Scope:	152 acres
Field Hours:	Three hours
Finds:	World War II-era shipyard

CONTENTS

FIGURES

INTRODUCTION

This report describes a cultural resources survey for the Napa Pipe Project, 1025 Kaiser Road, Napa County, California. The study area is located in southern Napa County, three miles south of downtown Napa, on the east shore of the Napa River opposite ‘Horseshoe Bend’ (Figure 1). The parcel consists of approximately 152 acres of level land, much of which was formerly river marsh. The study was requested by Design, Community & Environment, representing the project proponent, Napa Redevelopment Partners. Documentation pertaining to this study is on file at Tom Origer & Associates (File No. 06-95S).

REGULATORY CONTEXT

The California Environmental Quality Act (CEQA) requires that cultural resources be considered during the environmental review process. This is accomplished by an inventory of resources within a study area and by assessing the potential that cultural resources could be affected by development.

This cultural resources survey was designed to satisfy environmental issues specified in the CEQA and its guidelines (Title 14 CCR §15064.5) by: (1) identifying all cultural resources within the project area; (2) offering a preliminary significance evaluation of the identified cultural resources; (3) assessing resource vulnerability to effects that could arise from project activities; and (4) offering suggestions designed to protect resource integrity, as warranted.

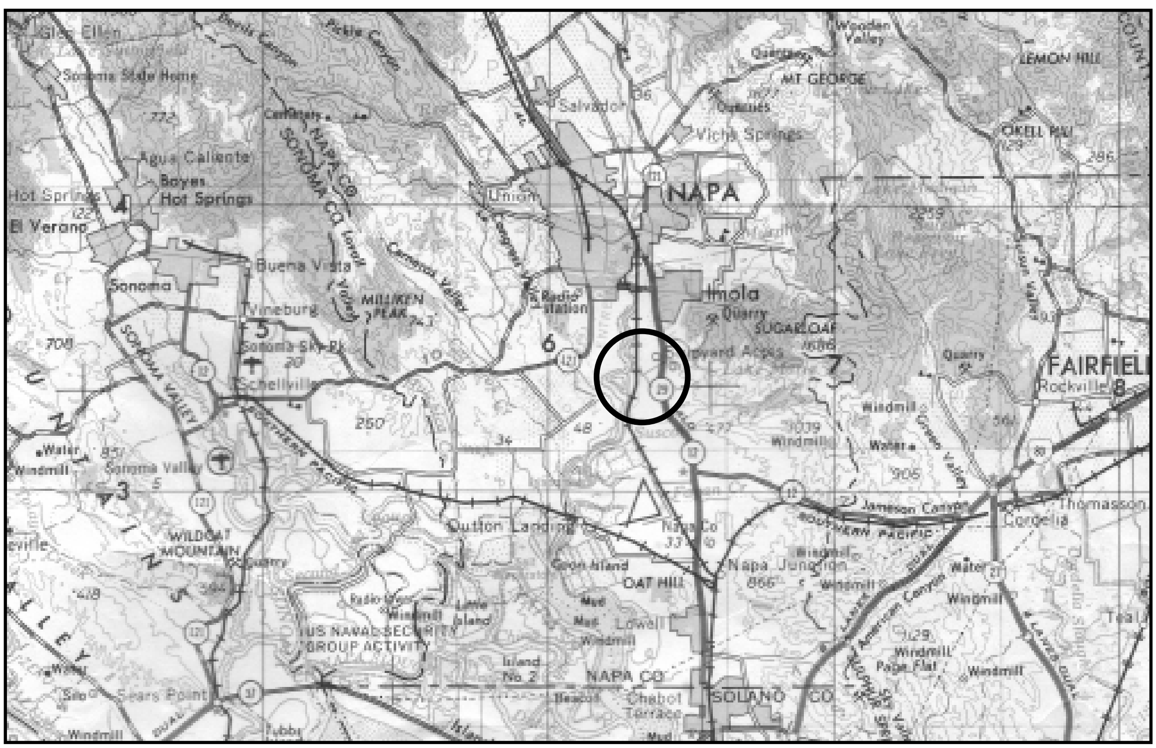

Figure 1. Project vicinity (adapted from the 1970 Santa Rosa 1:250,000-scale USGS map).

1

Resource Definitions

Cultural resources are classified by the State Office of Historic Preservation (OHP) as sites, buildings, structures, objects and districts, and each is described by OHP (1995) as follows.

> **Site.** A site is the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself possesses historic, cultural, or archaeological value regardless of the value of any existing structure.
>
> **Building.** A building, such as a house, barn, church, hotel, or similar construction, is created principally to shelter any form of human activity. "Building" may also be used to refer to a historically and functionally related unit, such as a courthouse and jail, or a house and barn.
>
> **Structure.** The term "structure" is used to distinguish from buildings those functional constructions made usually for purposes other than creating human shelter.
>
> **Object.** The term "object" is used to distinguish from buildings and structures those constructions that are primarily artistic in nature or are relatively small in scale and simply constructed. Although it may be, by nature or design, movable, an object is associated with a specific setting or environment.
>
> **District.** A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development.

Significance Criteria

When a project might affect a cultural resource, the project proponent is required to conduct an assessment to determine whether the effect may be one that is significant. Consequently, it is necessary to determine the importance of resources that could be affected. The importance of a resource is measured in terms of criteria for inclusion on the California Register of Historical Resources (Title 14 CCR, §4852) listed below. A resource may be important if it meets any one of the criteria below, or if it is already listed on the California Register of Historical Resources (California Register) or a local register of historical resources.

An important historical resource is one which:

1. Is associated with events that have made a significant contribution to the broad patterns of California's history or cultural heritage.

2. Is associated with the lives of persons important in our past.

3. Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values.

4. Has yielded, or may be likely to yield, information important in prehistory or history.

Additionally, the OHP advocates that all historical resources over 45 years old be recorded for inclusion in the OHP filing system (OHP 1995:2), although professional judgment is urged in determining whether a resource warrants documentation.

PROJECT SETTING

Study Area Location and Description

The Napa Pipe property is located in southern Napa County, about three miles south of downtown Napa, as shown on the Napa and Cuttings Wharf, California 7.5' USGS topographic quadrangles (Figure 2). The property address is 1025 Kaiser Road, in unincorporated Napa County. The study area is marked by level land, much of which is former marshland. Review of an 1858 topographic map of the Napa River environs shows extensive marshlands in this area with a slough winding through the current project area (Figure 3). Higher land is shown extending into the north end of the project area and into the southeast quadrant. The watercourse that forms the west boundary of the project area is an artificial channel of the Napa River, which eliminates a natural horseshoe bend in the river as an obstacle to navigation.

Soils mapped for this area are of the Reyes series (Lambert and Kashiwagi 1978:Sheet 43). Reyes soils are poorly drained, and are found in basins and tidal flats (Lambert and Kashiwagi 1978:32). Native vegetation on these soils is tule, salt grass, and other water loving plants. Historically these soils have been used for salt basins, and have been diked to grow oats, hay, and grain (Lambert and Kashiwagi 1978:32).

The geology of the study area is recent alluvium (Koenig 1963). Obsidian nodules are found in the bed of the nearby Napa River. This was of importance to prehistoric Native Americans who collected these nodules as raw material for making chipped stone tools such as projectile points, knives, and scrapers.

Situated as it is at the Napa River marsh edge, the study area and its surroundings would have been well-suited for prehistoric occupants of the region to hunt, and gather plant resources.

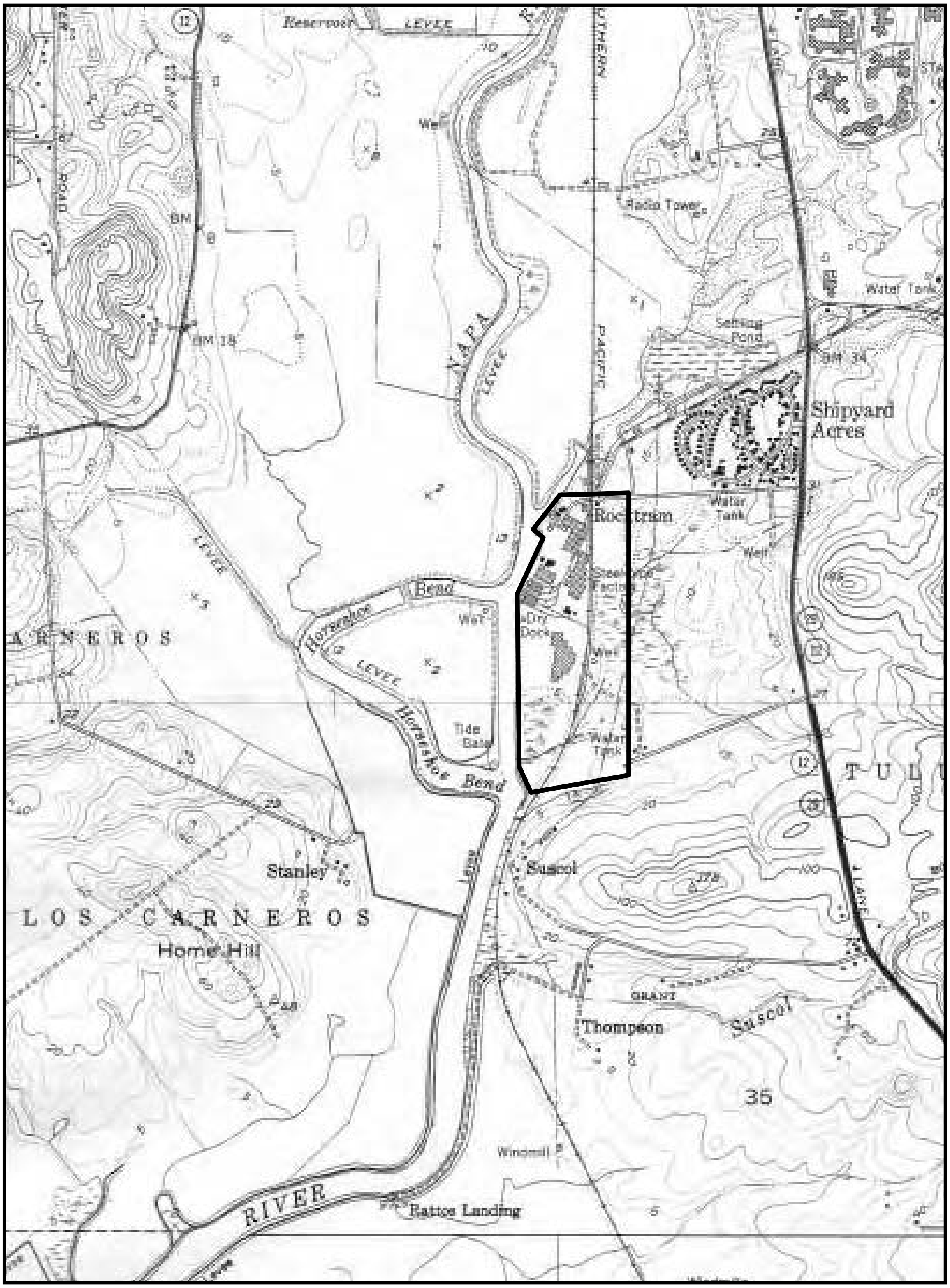

Figure 2. Study location (adapted from the USGS 1973 Napa and 1981 Cuttings Wharf 7.5' topographic maps).

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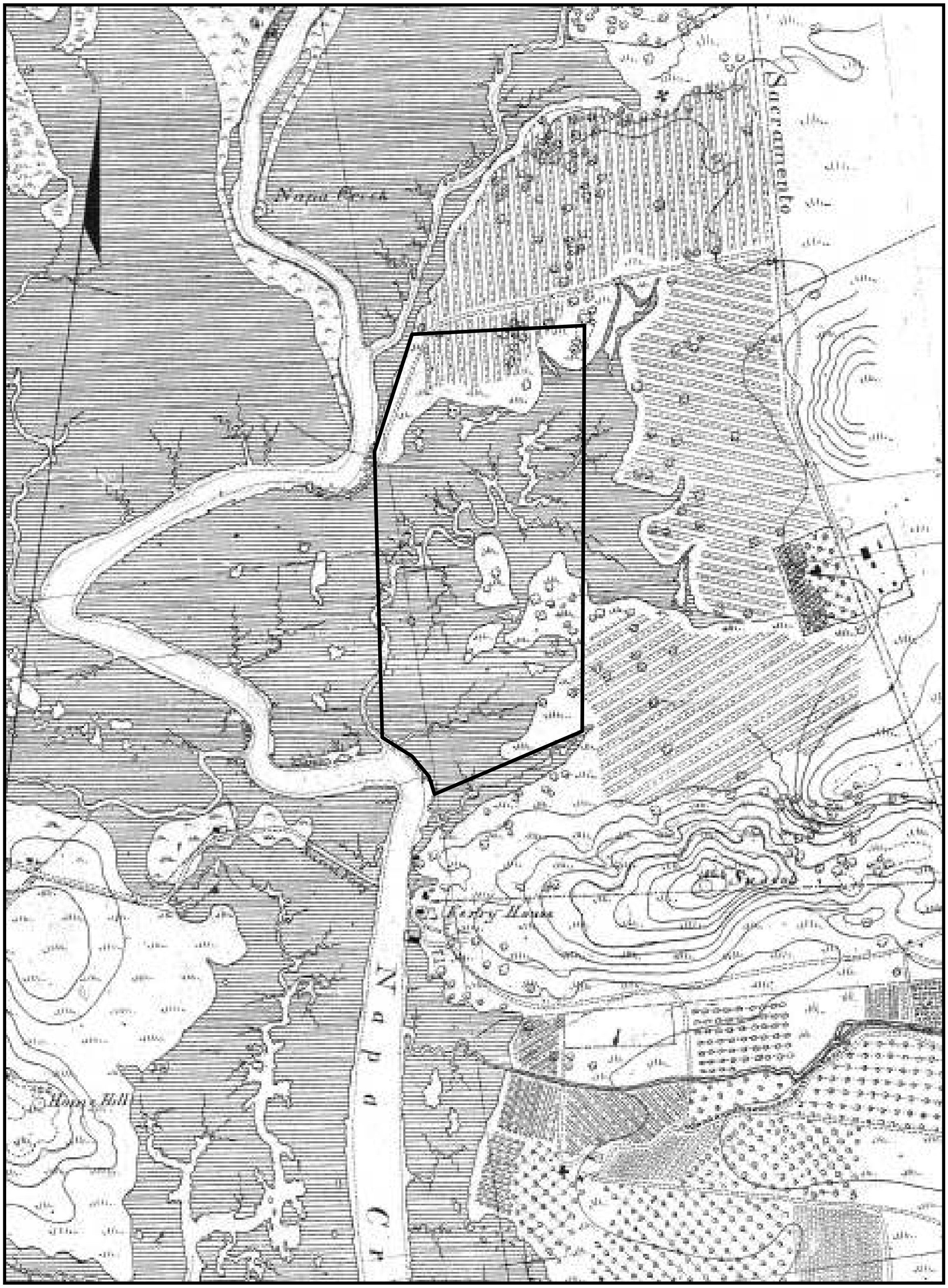

Figure 3. Approximate boundaries of study area circa 1858 (adapted from the USCS 1858 Napa Creek and Napa City 1:10,000-scale map).

Cultural Setting

Archaeological evidence indicates that human occupation of California began at least 12,000 years ago (Fredrickson 1984:506). Early occupants appear to have had an economy based largely on hunting, with limited exchange, and social structures based on extended family units. Later, milling technology and an inferred acorn economy were introduced. This diversification of economy appears to be coeval with the development of sedentism and population growth and expansion. Sociopolitical complexity and status distinctions based on wealth are also observable in the archaeological record, as evidenced by an increased range and distribution of trade goods (e.g., shell beads, obsidian tool stone), which are possible indicators of both status and increasingly complex exchange systems.

At the time of European settlement, the study area was included in territory controlled by the Southern Patwin (Johnson 1978). The Patwin were hunter-gatherers who lived in rich environ-ments that allowed for dense populations with complex social structures (Kroeber 1925). They settled in large, permanent villages about which were distributed seasonal camps and task-specific sites. Primary village sites were occupied year-round, and other sites were visited in order to procure particular resources that were especially abundant or available only during certain seasons. Sites often were situated near fresh water sources and in ecotones where plant life and animal life were diverse and abundant.

During the 1830s and 1840s, large tracts of land were given to Spanish (later Mexican) settlers by their government. These landgrants generally included much of California's prime valley lands, including several along the Napa River. The study area is within the Tulucay Rancho grant made to Cayetano Juares in 1840 and confirmed to him by the United States Land Commission in 1859, after the United States took possession of the area. A survey map of Tulucay Rancho shows that the current study area was primarily marshlands, with just the southeastern edge of the 152-acre property above sea level (General Land Office 1859).

STUDY PROCEDURES AND RESULTS

Archival Study Procedures

Archival research included examination of the library and project files at Tom Origer & Associates. A review (NWIC 06-369) was completed of the archaeological site base maps and records, survey reports, and other materials on file at the Northwest Information Center (NWIC), Sonoma State University. Sources of information included but were not limited to the current listings of properties on the National Register of Historic Places, California Register of Historical Resources, and California Points of Historical Interest as listed in the Office of Historic Preservation's *Historic Property Directory* (OHP 2007).

The Office of Historic Preservation has determined that structures in excess of 45 years of age should be considered potentially important historical resources, and former building and structure locations could be potentially important historic archaeological sites. Archival research included an examination of historical maps to gain insight into the nature and extent of historical development in the vicinity, and within the study area. Maps ranged from hand-drawn maps of the 1800s (e.g., General Land Office, United States Coast Survey [USCS]) to topographic maps issued by the United States Geological Survey (USGS) and United States Army Corps of Engineers (USACE).

In addition, ethnographic literature that describes appropriate Native American groups, county histories, and other primary and secondary sources were reviewed. Sources reviewed are listed in the "Materials Consulted" section of this report.

Archival Study Results

Archival research found that the study area had not been the subject of past cultural resources survey, and that there were 11 known resources within a one-mile radius of the study area.

Review of the ethnographic literature found reference to the village of *sû'skōl*, described as being "on the east bank of the Napa river probably at or near the present town of Suscol" Barrett (1908:293). Suscol town was located about a quarter-mile south of the study area, at the western toe of a prominent hill, north of Suscol Creek. Archaeological investigations were conducted at *sû'skōl* (CA-NAP-15) as part of the Napa Bypass project in 1979 (Schwaderer, Stradford, and Fredrickson 1979)

Review of historical maps found no buildings, structures, or other historical features within the study area prior to the 20th century (Buckman 1895; General Land Office 1859, USCS 1858). The USGS 1902 Napa map shows one building near the north end of the study area, on land that belonged to C.M.A. Buckley, and the Calistoga Branch of the Southern Pacific Railroad running north and south through the study area (Buckman 1895; USGS 1902). The 1951 USGS map shows the shipyard in place and the Rocktram rail stop (USGS 1951).

Native American Correspondence

A letter was sent to the State of California's Native American Heritage Commission seeking information from the sacred lands files, which track Native American cultural resources, and the names of Native American individuals and groups that would be appropriate to contact regarding this project. The Native American Heritage Commission responded by letter dated October 19, 2007, indicating that they had no record of cultural resources in the study area. Letters were also sent to the following:

> Elaine Patterson, Chairperson, Cortina Band of Indians
> Marshall McKay, Chairperson, Rumsey Indian Rancheria of Wintun
> Kesner Flores, Cultural Resources Specialist, Rumsey Indian Rancheria of Wintun
> Earl Couey, Cultural Resources Officer, Mishewal-Wappo Tribe of Alexander Valley
> Wintun Environmental Protection Agency

A log of contact efforts and results is provided at the end of this report (Appendix A).

Field Survey Procedures

Based on the results of archival research, it was anticipated that historic-period resources would be found within the study area, with a lesser potential that prehistoric resources would be found. To identify cultural resources within the study area, a field survey of the study area was completed by the author October 16, 2007. Ground surface visibility was poor to fair, with development, fill, and vegetation obscuring the ground surface in most areas. When possible, a hoe was used to clear small areas so that the surface could be examined.

Prehistoric archaeological site indicators expected to be found in the region include but are not limited to: obsidian and chert flakes and chipped stone tools; grinding and mashing implements such as slabs and handstones, and mortars and pestles; bedrock outcrops and boulders with mortar cups; and locally darkened midden soils containing some of the previously listed items plus fragments of bone, shellfish, and fire affected stones. Historic-period site indicators generally include: fragments of glass, ceramic, and metal objects; milled and split lumber; and structure and feature remains such as building foundations and discrete trash deposits (e.g., wells, privy pits, dumps).

Field Survey Results

Archaeology. No prehistoric or historic-period archaeological deposits were found within the study area.

Built Environment. The study area comprises the Basalt Shipyard, which dates to the late-1930s and 1940s. The shipyard was built shortly after 1938 by the nearby Basalt Rock Company. Needing barges to haul quarried stone to the San Francisco Bay area, the company opened their own shipyard to build steel barges, and later was contracted by the U.S. Navy to build ocean-going barges. Basalt would eventually build several self-propelled ships for the Navy, primarily mine layers and salvages ships (Akerman 2006). A primary record was completed for the shipyard, and is provided in Appendix B.

RECOMMENDATIONS

Archaeology

No archaeological resources were found within the study area; however, most of the study area is covered by buildings, structures, and fill so that the ground surface could not be adequately examined. As part of this study, we reviewed archaeological data, historical maps, and boring logs for soil tests made on the property. We found that known prehistoric archaeological sites in this area are found at elevations of from 10 to 20 feet above sea-level, or higher. Historically, the northern end and portions of the southeastern quadrant of the study area had elevations of 10 feet or more, and there is the possibility that buried archaeological deposits could be encountered during construction. We recommend that a professional archaeologist monitor any earth-disturbing activities in those areas. A map showing areas of concern is included as Appendix C.

Built Environment

The old Basalt Shipyard could be eligible for inclusion on the California Register and its importance should be evaluated pursuant to CEQA and its guidelines.

Accidental Discovery

There is the possibility that buried archaeological deposits could be present, and accidental discovery could occur. In keeping with the CEQA guidelines, if archaeological remains are uncovered, work at the place of discovery should be halted immediately until a qualified archaeologist can evaluate the finds (§15064.5 [f]). Prehistoric archaeological site indicators include: obsidian and chert flakes and chipped stone tools; grinding and mashing implements (e.g., slabs and handstones, and mortars and pestles); bedrock outcrops and boulders with mortar cups; and locally darkened midden soils. Midden soils may contain a combination of any of the previously listed items with the possible addition of bone and shell remains, and fire affected stones. Historic period site indicators generally include: fragments of glass, ceramic, and metal objects; milled and split lumber; and structure and feature remains such as building foundations and discrete trash deposits (e.g., wells, privy pits, dumps).

The following actions are promulgated in the CEQA Guidelines Section 15064.5(d) and pertain to the discovery of human remains. If human remains are encountered, excavation or disturbance of the location must be halted in the vicinity of the find, and the county coroner contacted. If the coroner determines the remains are Native American, the coroner will contact the Native American Heritage Commission. The Native American Heritage Commission will identify the person or persons believed to be most likely descended from the deceased Native American. The most likely descendent makes recommendations regarding the treatment of the remains with appropriate dignity.

SUMMARY

Tom Origer & Associates conducted a cultural resources survey for the Napa Pipe Project, Napa County, California. The study was requested by Design, Community & Environment, representing the project proponent, Napa Redevelopment Partners. No prehistoric or historic-period archaeological sites were found during the survey but it should be noted that native soils are obscured over most of the study area. We recommend construction monitoring by an archaeologist within certain parts of the study area. Appendix C provides a map showing locations where archaeological deposits are most likely to be encountered.

In addition, the study area contains the old Basalt Shipyard. A primary form (Appendix B) was completed for this resource. The shipyard should be evaluated for inclusion on the California Register prior to the commencement of project activities.

MATERIALS CONSULTED

Akerman, J.
2006 The Basalt ARS. *Towline*, April 2006. National Association of Fleet Tug Sailors. http://nafts.org/towline/Apr06towline.pdf <September 2007>

Barrett, S.
1908 *The Ethno-Geography of the Pomo and Neighboring Indians.* University of California Publications in American Archaeology and Ethnology Vol. 6(1). University of California Press, Berkeley.

Buckman, O.
1895 *Official Map of the County of Napa, California*. Punnett Bros., San Francisco.

Fredrickson, D.
1984 The North Coastal Region. In *California Archaeology*, edited by M. Moratto. Academic Press, San Francisco.

General Land Office (GLO)
1859 Plat of the Tulucay Rancho finally confirmed to Cayetano Juares. Department of the Interior, Washington, D.C.

Heizer, R. (editor)
1953 The Archaeology of the Napa Region. Anthropological Records 12(6). University of California Publications, Berkeley.

Hoover, M., H. Rensch, E. Rensch, and W. Abeloe
1966 *Historic Spots in California.* 3rd ed., Stanford University Press. Stanford.

Hoover, M., H. Rensch, E. Rensch, W. Abeloe, and D. Kyle
1990 *Historic Spots in California.* 4th ed., Stanford University Press. Stanford.

Johnson, P.
1978 Patwin. In *California*, edited by R. Heizer. Handbook of North American Indians, Vol. 8, pp. 350-360W. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

Koenig, J.
1963 Geologic Map of California, Santa Rosa Sheet (1:250,000-scale). Olaf P. Jenkins edition. Division of Mines and Geology, Williams & Heintz Map Corporation, Washington, D.C.

Kroeber, A.
1925 *Handbook of the Indians of California.* Bureau of American Ethnology, Bulletin 78, Smithsonian Institution, Washington, D.C.

1932 *The Patwin and Their Neighbors*. University of California Publications in American Archaeology and Ethnology Vol. 29, No. 4, pp. 253-423. University of California Press, Berkeley.

Lambert, G. and J. Kashiwagi
1978 *Soil Survey of Napa County, California.* United States Department of Agriculture Soil Conservation Service in cooperation with the University of California Agricultural Experiment Station.

Meighan, C.
1955 *Archaeology of the North Coast Ranges, California.* Reports of the University of California Archaeological Survey No. 30. Berkeley.

Menefee, C. A.
1873 *Historical and Descriptive Sketchbook of Napa, Sonoma, Lake and Mendocino.* Reporter Publishing House, Napa City.

Moratto, M.
1984 *California Archaeology.* Academic Press, San Francisco.

Office of Historic Preservation
1995 *Instructions for Recording Historic Resources*. Office of Historic Preservation, Sacramento.

2007 *Historic Property Directory*. Office of Historic Preservation, Sacramento.

Powers, S.
1877 *Tribes of California*. Contributions to North American Ethnology 3. United States Geographical and Geological Survey of the Rocky Mountain Region. Washington D.C. reprinted by the University of California Press, Berkeley.

Schwaderer, R., R. Stradford, and D. Fredrickson
1979 *An Archaeological Study of the Suscol Village, CA-NAP-15, Napa County California*. Document on file at the Northwest Information Center, Sonoma State University, Rohnert Park.

C. Smith & W. Elliot
1878 *Illustrations of Napa County, California with Historical Sketch.* Reprinted in 1974 by Valley Publishers, Fresno.

State of California Department of Parks and Recreation
1976 *California Inventory of Historic Resources.* Department of Parks and Recreation, Sacramento.

United States Army Corps of Engineers
1942 Sonoma. 15’ Tactical map. War Department, Washington, D.C.

United States Coast Survey
1858 Napa Creek and Napa City, California. No. XXXII, Register No. 777.

United States Geological Survey
1902 Napa, California. 30’ map. Geological Survey, Washington, D.C.

1951 Napa, California. 15’ map. Department of the Interior, Geological Survey, Washington, D.C.

MITI□ATION MONITORIN□ AND REPORTIN□ PRO□RAM

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Exhibit B:
NAPA PIPE MITIGATION MONITORING AND REPORTING PROGRAM

Note: for purposes of this MMRP, unless otherwise indicated the term "Project Applicant" shall mean the project applicant and successors in interest or other persons assuming responsibility for implementation of the mitigation measures under the Development Plan, Applicable Permits, or transfer documents.

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
TRAFFIC AND TRANSPORTATION				
TRA-1b: To lessen the severity of significant peak hour traffic impacts at all studied intersections (and potentially reduce impacts to less than significant at the intersections of First St/Soscol Ave; Third St/Silverado Tr.(SR 121)/East Ave/Coombsville Rd; SR 29 Northbound Ramps/Imola Ave, Imola Ave (SR 121)/Jefferson St, SR 221 (Napa-Vallejo Hwy)/Kaiser Road, the project applicant shall establish a transportation demand management (TDM) program which shall be funded and administered by the property owners association with the goal of reducing the forecasted auto trip generation from the project by 15 percent. The TDM program shall include certain required (immediate, long term) measures, as follows. Required TDM Measures • Establish a full-time, paid TDM coordinator to implement required TDM measures, monitor their effectiveness and implement additional measures as needed to meet the 15 percent goal. The coordinator shall also monitor volumes and delays at intersections where traffic mitigation measures have been called for. • Implement peak period shuttle service to key employment centers (e.g. hospital, downtown) or provide funding to allow relocation of the nearby VINE route to serve the site, with added service in peak periods. • Implement a parking management program to establish and monitor compliance with parking restrictions. The effectiveness of these required measures shall be monitored on a biannual basis, and traffic counts will be conducted to determine if the 15 percent reduction of forecasted traffic levels is being achieved. If additional measures are necessary to achieve the 15 percent reduction, the TDM coordinator shall implement other measures to enhance the TDM program. Below is a selection of additional measures that may be considered to achieve a reduction in auto traffic: • Develop incentives for employer programs	Project Applicant and Property Owners Assoc. are responsible for implementing this mitigation measure as stated.	Dept. of Public Works; County Counsel	TDM Program shall be established and set forth in conjunction with Conditions, Covenants and Restrictions of the Homeowners/Property Owners Association prior to issuance of Certificates of Occupancy (CC&R's to be reviewed and approved by County Counsel)	

[1] These Mitigation Measures reflect revisions arising from discussions with the City of Napa and Napa Redevelopment Partners since the Board of Supervisor's hearing of May 21, 2013. Additional revisions may be considered and adopted concurrent with the project's development plan, design guidelines, and development agreement

1

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
• Guaranteed Ride Home Program • Information kiosk w/brochures • Newsletter articles • Advertised carpool information phone number • Annual promotional events • Car-share program • Shuttles to regional transit like the Vallejo ferry • Transit Subsidies • Water taxis • On-site Ticket Sales (some level also included in existing, initial, moderate) • Carpool/Vanpool Subsidies (Start up, empty seat subsidies) • Employer-owned/sponsored Vanpools • Fleet Vehicles for mid-day trips • On-site circulator shuttle or golf-carts and/or campus bicycles • Aggressive flextime/telecommute programs				
TRA-5: At the intersection of Imola Avenue/Soscol Avenue, prior to issuance of building permits, the project applicant shall pay its fair share toward construction of an additional through lane and left-turn lane on the eastbound approach, an exclusive right-turn lane on the westbound approach, and an additional through lane on Soscol Avenue in both directions. Provide protected phasing for the eastbound and westbound left-turn movements.	Project Applicant or Property Owners Assoc. pays fair share to Napa Pipe Traffic Mitigation Fee Program prior to issuance of building permits.	TDM program manager; Dept. of Public Works.	County shall establish, based on studies funded by Project Applicant, a Napa Pipe Traffic Mitigation Fee Program. Fair share payment as determined by that Program shall be paid to Program prior to issuance of building permits, and dispersed for construction of improvement if and when improvement is constructed.	
TRA-6: At the intersection of State Route 221 (Napa-Vallejo Highway)/Streblow Drive, construct an additional northbound left-turn lane on State Route 221 (Napa-Vallejo Highway) and a receiving lane on Streblow Drive pursuant to Caltrans standards prior to the occupancy of the project. The TDM program manager shall monitor project-generated traffic and operations of this intersection on an annual basis with the County's oversight after permits are issued for the project. Monitoring shall be used to determine if and when	Property Owners Assoc. and TDM program manager to implement measure as stated. Owners Association shall	TDM program manager and Property Owners Assoc.; Dept. of Public Works.	Intersection monitored by TDM program manager on annual basis, and when traffic flows warrant, Owners	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
the required improvement is warranted by project generated traffic at the intersection. If warranted, the property owners association shall be responsible for implementing the required improvement to the intersection.	work with City of Napa and Caltrans to obtain consent to construct improvement if warranted.		Assoc. to work with City of Napa /Caltrans to obtain consent to construct improvement.	
TRA-8: At the intersection of Soscol Ferry Road/Devlin Road, forecasted volumes warrant a traffic signal; however, the intersection's close proximity to an adjacent signalized intersection renders a standard signalized intersection infeasible. Construct a median treatment on Soscol Ferry Road that essentially controls all movements except for the westbound through movement on Soscol Ferry Road. Widen Soscol Ferry Road to the west of its intersection with Devlin Road to allow for merging of the two lanes. The merge distance shall be in accordance with the standard roadway design criteria for lane merges. Please see the figure presented in the Traffic Impact Analysis in Appendix E of the Napa Pipe 2009 DEIR. This improvement shall be constructed prior to the occupancy of the project.	Project applicant to pay County costs associated with making the identified improvements and construction.	Planning Dept. and Dept. of Public Works	Department of Public Works shall verify construction of improvement prior to issuance of Certificates of Occupancy.	
TRA-9: At juncture of SR 12-SR 29/SR 221 (Napa-Vallejo Highway), prior to issuance of building permits the project applicant shall pay its pro-rated fair share toward the construction a flyover ramp for the traffic traveling from southbound State Route 221 (Napa-Vallejo Highway) to southbound State Route 12/State Route 29.	Project Applicant or Property Owners Assoc. pays fair share to Napa Pipe Traffic Mitigation Fee Program prior to issuance of building permits.	Planning Dept. and Dept. of Public Works.	County shall establish, based on studies funded by Project Applicant, a Napa Pipe Traffic Mitigation Fee Program. Fair share payment as determined by that Program shall be paid into Program prior to issuance of building permits, and dispersed for construction of improvement if and when improvement is constructed.	
TRA-10: At juncture of SR 12/Airport Boulevard/SR 29, prior to issuance of building permits the project applicant shall pay its pro-rated fair share toward the construction of a grade-separated interchange as proposed in the Napa County General Plan. This improvement has been contemplated previously by the County and Caltrans, and is likely to be needed with or without development of the project.	Project Applicant or Property Owners Assoc. pays fair share to Napa Pipe Traffic Mitigation Fee Program prior to issuance of build-	Planning Dept. and Dept. of Public Works	County shall establish, based on studies funded by Project Applicant, a Napa Pipe Traffic Mitigation Fee Program. Fair share	

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
	ing permits.		payment as determined by that Program shall be paid to Program prior to issuance of building permits, and dispersed for construction of improvement if and when improvement is constructed.	
TRA-11: State Route 29/Napa Junction Road intersection: The Napa County General Plan calls for widening of State Route 29 from the State Route 221 (Napa-Vallejo Highway) interchange to the southern County Line. In order to mitigate the project's significant impact based on the criteria described earlier in the FEIR, the additional through lane on State Route 29 in the northbound and southbound directions shall be constructed at this intersection, as is currently proposed. This improvement has been contemplated previously by the County and Caltrans, and is likely to be needed with or without development of the project. For this reason, the project applicant shall pay its fair share to the construction of this project prior to issuance of building permits to avoid a significant impact. With the widening of State Route 29, this intersection would improve to acceptable LOS C in the AM and PM peak hours.	Project Applicant or Property Owners Assoc. pays fair share to Napa Pipe Traffic Mitigation Fee Program prior to issuance of building permits.	Dept. of Public Works.	County shall establish, based on studies funded by Project Applicant, a Napa Pipe Traffic Mitigation Fee Program. Fair share payment as determined by that Program shall be paid to Program prior to issuance of building permits, and dispersed for construction of improvement if and when improvement is constructed.	
TRA-12: State Route 29/Donaldson Way intersection: The Napa County General Plan calls for widening of State Route 29 from the State Route 221 (Napa-Vallejo Highway) interchange to the southern County Line. In order to mitigate the project's significant impact based on the criteria described in the FEIR, the additional through lane on State Route 29 in the northbound and southbound directions shall be constructed at this intersection, as is currently proposed. For this reason, the project applicant shall pay its fair share to the construction of this project prior to issuance of building permits to avoid a significant impact. With the widening of State Route 29, this intersection would improve to acceptable LOS B in both the AM and PM peak hours.	Project Applicant or Property Owners Assoc. pays fair share to Napa Pipe Traffic Mitigation Fee Program prior to issuance of building permits.	Dept. of Public Works.	County shall establish, based on studies funded by Project Applicant, a Napa Pipe Traffic Mitigation Fee Program. Fair share payment as determined by that Program shall be paid to Program prior to	

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
			issuance of building permits, and dispersed for construction of improvement if and when improvement is constructed.	
TRA-13: State Route 29/American Canyon intersection: The City of American Canyon's General Plan recognizes that this intersection will likely operate at LOS E conditions during peak periods. The Napa County General Plan also calls for widening of State Route 29 from the State Route 221 (Napa-Vallejo Highway) interchange to the southern County Line. In order to mitigate the project's significant impact based on the criteria described in the FEIR, the additional through lane on State Route 29 in the northbound and southbound directions shall be constructed at this intersection, as is currently proposed. For this reason, the project applicant shall pay its fair share to the construction of this project prior to issuance of building permits to avoid a significant impact. With the widening of State Route 29, this intersection would continue to operate at LOS F in the AM peak hour (primarily due to the extremely heavy westbound right turn to northbound State Route 29), but would operate better than Existing conditions without the project. The intersection would improve to LOS D in the PM peak hour.	Project Applicant or Property Owners Assoc. pays fair share to Napa Pipe Traffic Mitigation Fee Program prior to issuance of building permits.	Dept. of Public Works.	County shall establish, based on studies funded by Project Applicant, a Napa Pipe Traffic Mitigation Fee Program. Fair share payment as determined by that Program shall be paid to Program prior to issuance of building permits, and dispersed for construction of improvement if and when improvement is constructed.	
TRA-14: The Project Sponsor shall develop and implement a Construction Traffic Management Program ("CMP") to minimize impacts of the Project and its contribution to cumulative impacts related to both on and off-site construction and remediation activities and traffic. The program shall provide necessary information to various contractors and agencies as to how to maximize the opportunities for complementing construction management measures and to minimize the possibility of conflicting impacts on the roadway system, while safely accommodating the traveling public in the area. The program shall supplement and expand, rather than modify or supersede any manual, regulations, or provisions set forth by Napa County departments and agencies. Preparation of the Construction Management Program shall be the responsibility of the Project Sponsor, and shall be reviewed and approved by County staff prior to initiation of construction. The program shall: • Identify construction traffic management practices in Napa County, as well as other jurisdictions that could provide useful guidance for a project of this size and characteristic.	Project Applicant is responsible for developing and obtaining approval of the CMP. Actual implementation of CMP measures is the responsibility of Project Applicant and its construction contractors.	Dept. of Public Works.	Prior to commencement of grading/construction activities and issuance of any related permits, Project Applicant shall submit CMP to Dept. of Public Works for approval. Project Applicant shall require adherence to CMP measures as a con-	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
• Describe procedures required by different departments and/or agencies in the County for implementation of a construction management plan, such as reviewing agencies, approval process, and estimated timelines. • Identify construction traffic management strategies and other elements for the Project, and present a cohesive program of operational and demand management strategies designed to maintain acceptable traffic operations during periods of construction activities in the Project area. These could include construction strategies, demand management strategies, alternate route strategies, and public information strategies. • Coordinate with other projects in construction in the immediate vicinity (i.e. Syar), so that they can take an integrated approach to construction-related traffic impacts. • Identify barge routes to access the project site and other information as required by Napa County in the event soil import may be serviced by barge via the Napa River. • Ensure that adequate pedestrian circulation is maintained when the-existing sidewalks must be closed or obstructed for construction purposes. • Ensure that adequate bicycle facilities are maintained, including detour signs for then-existing bicycle routes. • Ensure that construction-truck traffic follows established truck routes, where designated. • Ensure that transit facilities, including stops, locations and associated amenities, such as shelters, etc., are maintained, or that acceptable temporary facilities are established. Implementation of the CMP would help reduce the Proposed Project's construction-related traffic impacts. Given the magnitude of the proposed development and the duration of the construction period, some disruptions and increased delays could still occur even with implementation of the CMP, although these disruptions would not be considered a significant impact because they would be intermittent over the course of the construction period.			tractual condition with all construction contractors. During construction, Dept. of Public Works shall conduct periodic inspections to determine compliance with CMP measures.	
<u>TRA-15</u>: To mitigate potential adverse affects on roadway pavement conditions, prior to beginning construction on the proposed project, survey road conditions for proposed trucking routes on the following roadways: ♦ Kaiser Road ♦ Napa Valley Corporate Drive ♦ Napa Valley Corporate Way ♦ Bordeaux Way ♦ Anselmo Court	Project Applicant shall retain qualified consultant (approved by the County) to conduct the road survey and implement mitigation measure as	Dept. of Public Works.	Schedule shall be as stated in mitigation measure.	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
♦ Soscol Ferry Road This shall include roadway pavement and other surfaces that construction traffic may cross. The project applicant shall return roadway conditions to their pre-construction conditions (or better) following the remediation and grading phase of the project. For subsequent construction phasing, truck traffic to/from the project shall be monitored on the identified roadways to determine project's construction traffic contribution to overall truck traffic. Project applicant shall pay a fair share contribution to return roadway conditions to their pre-construction conditions following each phase of construction.	stated.			
TRA-16: The design of the public promenade along the waterfront portion of the project shall minimize pedestrian and bicycle conflicts through means such as channelizing pedestrians to discrete crossing points of the trail, widening the trail through areas where higher pedestrian volumes are expected, and where necessary, separating pedestrian and bicycle travel.	Project Applicant submits Site Plan for public promenade area to Planning Dept. and Dept. of Public Works for approval.	Planning Dept. and Dept. of Public Works.	Prior to any construction and permitting of the public promenade area.	
TRA-17: To promote transit use, reroute the VINE #10 bus route through the project site to serve the proposed transit center as proposed in the project site plan and ensure that all development proposed would be within a reasonable walking distance to transit (less than ⅓-mile). The revised bus route through Napa Pipe could either be a loop, in which case existing stops along Napa Valley Corporate Drive would remain, or the route could be relocated. Under the latter option, the existing bus stop at Latour Court would be moved 450 feet to the north to Kaiser Road, the stop at Bordeaux Way would be moved 600 feet to the south to Anselmo Court, and the stop at Napa Valley Corporate Way would be eliminated. Stops at Napa Valley Corporate Drive's intersections with Kaiser Road and Anselmo Court will help maintain current patrons. Current ridership is expected to be maintained or surpassed by routing through the project. However, it should also be noted that the extension into the Napa Pipe site will lengthen the travel time from the City of Napa to the City of American Canyon, which may discourage current commuters. If the extension of the VINE #10 bus route is not feasible, the Project Applicant shall include peak period shuttle service as included in Mitigation Measure TRA-1b.	County and Project Applicant shall work with NCTPA to obtain approval of the bus rerouting. Project Applicant shall provide shuttle service as stated if rerouting does not occur.	Planning Dept. and TDM program manager.	Negotiations shall occur, and if necessary shuttle instituted, prior to issuance of Certificates of Occupancy.	
TRA-18: To address issues associated with off-street parking supply, the project applicant shall collaborate with County Staff to develop a parking monitoring plan that assesses the utilization of available parking, to be included in the development plan. Alternatively, implementation of a parking management program, a component presented in Mitigation Measure TRA-1b, could be implemented to monitor parking demand and carry out parking reduction strategies when needed.	Project Applicant shall address parking issues, with approval of County, in development plan.	Planning Dept.	Adequacy of parking shall be determined by Planning Dept. prior to commencement of construction in accordance with zoning regulations, or in approved develop-	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
			ment plan.	
TRA-19: To address project contribution to cumulative deterioration on roadway and intersection level of service operations, in addition to Mitigation Measures TRA-1 through TRA-13 (as applicable), the project applicant shall pay a fair share contribution to other long-term planned roadway improvements in the Regional Transportation Plan (assumed under the Cumulative Planned roadway network) at locations where the proposed project would contribute to cumulatively significant traffic impacts. The following improvements have been identified under this plan: ♦ Realignment of Silverado Trail at Soscol Avenue to match alignment of proposed Gasser Drive extension ♦ Widening of State Route 29 to six lanes between Airport Boulevard and southern Napa County line ♦ Extension of Devlin Road south to Green Island Road Each of these roadway improvements would improve intersection operations and general roadway circulation in the project study area under Cumulative conditions; however, most intersections would continue to operate unacceptably. A comprehensive list of roadway improvements that would be required to achieve acceptable intersection level of service under cumulative conditions has been developed and is presented in the Transportation Impact Analysis (Appendix E) of the 2009 DEIR. (See also, September 7, 2012 "Napa Pipe Impact Comparison—Costco Alternative/Proposed Project" Memorandum prepared by Fehr & Peers identifying the mitigation measures from the TIA that are applicable to the Developers Revised Proposal.) Many of these improvements would require major roadway widening in a fashion that may not be consistent with the stated desires of many communities, through their General Plan documents, to maintain Napa County's rural atmosphere and promote pedestrian, bicycle, and transit as successful transportation modes. Many of the cumulative impacts would occur even without the project.	Project Applicant or Property Owners Assoc. pays fair share to Napa Pipe Traffic Mitigation Fee Program prior to issuance of building permits.	Dept. of Public Works and Planning Dept.	County shall establish, based on studies funded by Project Applicant, a Napa Pipe Traffic Mitigation Fee Program. Fair share payment as determined by that Program shall be paid to Program prior to issuance of building permits, and dispersed for construction of improvement if and when improvement is constructed.	
BIOLOGICAL RESOURCES				
BIO-1: In the event that pre-construction confirmation surveys conducted in accordance with the Biological Resource Assessment ("BRA") protocols identify any federally- or State-listed plant species that have become established along shoreline areas proposed for bank work, the applicant shall obtain all necessary permits and/or authorizations from the CDFG and USFWS as required by federal and State law for incidental take of those species. If CNPS 1B plants are found in the area of proposed disturbance and cannot be avoided, a salvage/relocation plan shall be developed and approved by CDFG prior to initiation of bridge construction and other improvements in marshland habitat. Evidence that the applicant has secured any required authorization from these agencies shall be submitted to the Napa County Conservation, Development & Planning Department prior to issuance of any grading or building permits for the project.	Project Applicant retains qualified biologist (subject to County approval) to conduct confirmation survey, and is responsible for implementing mitigation measure as stated.	Planning Dept.	Survey conducted, and any necessary State or Federal permits/authorizations obtained, prior to issuance by County of any grading or building permits.	

Mitigation Measures[1]	**Implementation Procedure**	**Monitoring Responsibility**	**Monitoring / Reporting Action and Schedule**	**Monitoring Compliance Record (Name/Date)**
BIO-2: If project improvements affecting or adjacent to brackish marsh habitat are not initiated until after 2010, supplemental confirmation surveys conducted in accordance with the Biological Resource Assessment ("BRA") protocols shall be conducted to determine whether Mason's lilaeopsis, Delta tule pea, and other marsh associated special-status plant species have become established at the Bedford Slough bridge crossing and shoreline of the Napa River where the bridge over Asylum Slough is proposed. The surveys shall be conducted by a qualified botanist in the year prior to the anticipated start of construction, and shall be appropriately-timed to allow for detection of all species of concern (typically between April and November).	Project Applicant retains qualified biologist (subject to County approval) to conduct supplemental confirmation survey and implements mitigation measure as stated. If plant species detected, Project Applicant to obtain and necessary CDFG and USFWS permits/authorizations; implement *Avoidance/Minimization Measures During Construction* set forth in the Biological Resource Assessment (BRA).	Planning Dept.	Survey conducted, and any necessary State or Federal permits/authorizations obtained, prior to issuance by County of any grading or building permits. Project Applicant implements applicable BRA requirements.	
BIO-3(a): To avoid the potential for disturbance of nesting birds associated with marsh habitat on or near the site, schedule any construction activities that encroach within 300 feet of the brackish marsh, diagonal drainage, and Bedford Slough for the period of August 16 through February 14. If construction work cannot be scheduled during this period, a qualified biologist shall conduct pre-construction surveys for nesting birds in the wetland habitats. The surveys shall be conducted no later than 14 days prior to the start of work and shall focus on determining whether San Pablo song sparrow, saltmarsh common yellowthroat and/or tricolored blackbird are nesting in these areas. If these or other birds protected under the Migratory Bird Treaty Act or CDFG Code 3503 are found nesting, then appropriate construction buffers shall be established to avoid disturbance of the nests until such time that the young have fledged. The size of the nest buffer shall be determined by the biologist in consultation with CDFG, and shall be based on the nesting species, its sensitivity to disturbance, and expected types of disturbance. Typically, these buffers range from 150 to 250 feet from the nest site. Nesting activities shall be monitored periodically by a qualified biologist to determine when construction activities in the buffer area can resume. The nest buffer shall remain in effect and the nest protected until the young have fledged and the nest is no longer in active use, as determined by the quali-	Project Applicant implements mitigation measure as stated. Retention of qualified biologist if necessary is subject to County approval.	Planning Dept.	Planning Dept. shall monitor construction timing; If needed, qualified biologist to consult with CDFG, provide periodic monitoring of construction, and report results to Planning Dept.	

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
fied biologist.				
BIO-3(b): Tree and brush removal on the remainder of the project site (those areas not subject to BIO-3(a)), shall take place during the period of August 16 through February 14 to the maximum extent possible to avoid possible disturbance to nesting birds. If tree and brush removal cannot take place outside of this timeframe, a qualified biologist shall conduct pre-construction surveys for nesting birds in the trees and brush to be removed no later than 14 days prior to the start of work. If active nests of raptors or other birds protected under the Migratory Bird Treaty Act or CDFG Code 3503 are located in trees or brush to be removed, then appropriate construction buffers shall be established to avoid disturbance of the nests until such time that the young have fledged and the nest is no longer active, as determined by a qualified biologist. The size of the buffer shall be determined by the biologist in consultation with CDFG, and shall be based on the nesting species, its sensitivity to disturbance, and expected types of disturbance.	Project Applicant implements mitigation measure as stated. Retention of qualified biologist if necessary is subject to County approval.	Planning Dept.	Planning Dept. shall monitor construction timing; If needed, qualified biologist to consult with CDFG, provide periodic monitoring of construction, and report results to Planning Dept.	
BIO-3(c): A qualified biologist shall conduct pre-construction surveys in the annual grassland and ruderal brushland habitats on the site to confirm that there are no burrowing owls or northern harriers nesting in these areas. The surveys shall be conducted no later than 30 days prior to the start of ground disturbing activities in these areas. If construction is initiated in these areas during the period of August 31 through January 31, then pre-construction surveys are not required. If active nests of either species are discovered in the proposed area of disturbance or within 300 feet of this area, the biologist shall consult with CDFG to determine the appropriate construction buffer. Once the biologist determines that the nests are no longer active, then construction activities can resume within the buffer area.	Project Applicant implements mitigation measure as stated. Retention of qualified biologist if necessary is subject to County approval.	Planning Dept.	Planning Dept. shall monitor construction timing; If needed, qualified biologist to consult with CDFG, provide periodic monitoring of construction, and report results to Planning Dept.	
BIO-4(a): In the event that work is required below the Ordinary High Water Mark in the Napa River, Asylum Slough or Bedford Slough, the applicant shall obtain all necessary authorizations from the CDFG and NOAA Fisheries as required by federal and State law for potential harm to special-status fish species. Such authorization would be obtained as a result of interagency coordination through USACE and/or Coast Guard permit(s) and the CDFG Streambed Alteration process (see Mitigation Measure BIO-5 below). Evidence that the applicant has secured any required authorization from these agencies shall be submitted to the Napa County Conservation, Development & Planning Department prior to issuance of any grading or building permits for the project.	Project Applicant implements mitigation measure as stated, and obtains all necessary state and federal authorizations.	Planning Dept.	Evidence of obtaining necessary authorizations submitted to Planning Dept. prior to issuance of any grading or building permit.	
BIO-4(b): To avoid potential impacts to Central California steelhead that may be in the Napa River, in-water construction in Asylum Slough or Bedford Slough shall not occur between January through April.	Project Applicant implements mitigation measure as stated	Planning Dept.	Planning Dept. periodically monitors construction activity during prohibited times.	
BIO-4(c): To avoid potential impacts to Delta smelt or Sacramento splittail that may be in the Napa River, in-water construction in Asylum Slough or Bedford Slough shall not occur between February through May. During the summer months, it is unlikely for these	Project Applicant implements mitigation measure as	Planning Dept.	Planning Dept. periodically monitors construction activity	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
species to be in this area of the river due to increased salinity.	stated.		during prohibited times.	
BIO-4(d): To avoid potential impacts to chum salmon that may be in the Napa River, in-water construction in Asylum Slough or Bedford Slough shall not occur between February through May.	Project Applicant implements mitigation measure as stated.	Planning Dept.	Planning Dept. periodically monitors construction activity during prohibited times.	
BIO-5: With respect to fill in jurisdictional wetlands and waters, the *Avoidance/Minimization Measures During Construction* called for in the BRA along with the following additional measures shall be implemented. ♦ Where verified waters of the United States are present and cannot be avoided, authorization for modifications to these features shall be obtained from the USACE through the Section 404 permitting process. Similarly, a Section 401 Certification shall be obtained from the RWQCB where waters of the United States are directly affected by the project. All conditions required as part of the authorizations by the USACE and RWQCB shall be implemented as part of the project. ♦ A CDFG Stream Bed Alteration Agreement shall also be required where proposed project activities would affect the bed or banks of Bedford Slough, Asylum Slough and other regulated drainages on the site. The applicant shall submit a notification form to the CDFG, shall obtain all legally-required agreements, and implement any conditions contained within that agreement. ♦ Consultation or incidental take permitting may be required under the California and federal Endangered Species Acts (as discussed above under Mitigation Measures BIO-1 and BIO-3). The applicant shall obtain all legally required permits or other authorizations from the USFWS, NOAA Fisheries, and CDFG for the potential "take" of protected species under the Endangered Species Acts. ♦ Install orange construction fencing around the boundary of all wetland areas to be preserved so that they are not disturbed during construction. The fencing shall be placed a minimum of 25 feet out from the boundary of the wetland but may need to be adjusted if restoration activities are to be conducted within this area. Grading, trail construction and restoration work within the 50-foot wetland buffer zones shall be conducted in a way that avoids or minimizes disturbance of existing wetlands. In some cases (e.g. at the connection point of the new swale with the diagonal drainage), this may mean use of smaller equipment such as a Bobcat. ♦ A biologist/restoration specialist shall be available during construction to provide situation-specific wetland avoidance measures or planting recommendation, as needed.	Project Applicant implements mitigation measure as stated, retaining a biologist/restoration specialist subject to County approval.	Planning Dept.	Project Applicant provides evidence of necessary state and federal authorizations prior to issuance of grading and building permits. Planning Dept. and retained biologist/restoration specialist periodically monitors construction activity during prohibited times.	
NOISE				

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
NOISE-1: In accordance with 2010 California Building Code (Chapter 12, Appendix Section 1207.11.2), sound-rated building construction shall be used to achieve acceptable indoor noise levels (45 dBA L_{dn}) in residential units along the east and north perimeters of the site. Building sound insulation treatments include, but are not limited to sound retardant windows and doors, resilient wall constructions, heavy siding and roofing materials (e.g. stucco, Hardi-plank), ventilation silencers, and gasketing. The specification of these treatments shall be developed during the architectural design of the buildings. All residential units in the project shall require mechanical ventilation to allow for air circulation while windows are closed for noise control. Through application of the design guidelines, residential outdoor use areas shall be shielded from traffic and industrial noise by locating buildings between these sources and the outdoor areas. Noise barriers would be utilized where additional shielding is required to achieve compatible noise levels in order to meet the requirements set forth in the Napa County Noise Ordinance, Section 8.16.070, Exterior Noise Limits.	Required mitigations shall be contained in the Design Guidelines and building plans submitted by Project Applicant to County for approval.	Building Dept.	Inclusion of identified measures in Development Plan and building plan submittals shall be confirmed by County prior to issuance of any building permit.	
NOISE-2: Locate proposed residential land uses no closer than 100 feet from the railroad tracks or require that railroad train vibration levels be confirmed by an analysis conducted by an expert in rail vibration during the detailed design phase of the project. Vibration levels shall not exceed the screening level threshold of 80 VdB or the detailed vibration impact criteria of 78 VdB during the day or 72 VdB at night at the proposed setback of residential units adjoining the tracks. The noise expert would recommend design level measures to mitigate any excessive vibration levels. Residential buildings shall not be constructed within 100 feet of active railroad tracks unless design measures that mitigate excessive vibration to levels below FTA impact thresholds are included in the project.	Project Applicant implements mitigation measure as stated. Retention of qualified vibration specialist subject to County approval. Location restrictions from vibration levels shall be confirmed in analysis and incorporated into Design Guidelines, site plan, and building submittal approvals.	Planning Dept.; Building Dept.	County shall confirm compliance with stated mitigations prior to issuance of building permits.	
AIR QUALITY				
AQ-2: The following is a list of feasible control measures that the BAAQMD recommends to limit construction emissions of PM_{10}, PM2.5, and NO_x. These mitigation measures shall be implemented for all areas (both on-site and off-site) where construction activities would occur. Even with mitigation measures imposed, this impact remains significant and unavoidable. Measures to Reduce Fugitive Particulate Matter (PM10 and PM2.5) Emissions All untreated exposed surfaces shall be watered at a frequency adequate to maintain minimum soil moisture of 12 percent. Moisture content can be verified by lab samples or	Project Applicant and its contractors shall implement the mitigation measure as stated. Identified measures shall be a contractual condition of construction	Planning Dept., Dept. of Public Works.	Plans and inventory of construction vehicle equipment to be used, and method of importing fill, shall be approved by Planning Dept. and/or Dept. of	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
moisture probe. ♦ Limit traffic speeds on any unpaved roads to 15 mph. ♦ Suspend construction activities that cause visible dust plumes to extend beyond construction sites, especially during windy conditions. ♦ Vegetative ground cover (e.g., fast-germinating native grass seed) shall be planted in disturbed areas as soon as possible and watered appropriately until vegetation is established. ♦ Prohibit the visible tracking of mud, dirt, or material on to public streets. If necessary, all trucks and equipment, including their tires, shall be washed off prior to leaving the site. Any visible mud or dirt tracked on to public roadways shall be removed using wet power vacuum sweepers at least once per day. ♦ During remediation and grading/fill import phases, site accesses to a distance of 100 feet from the paved road shall be treated with a 6 to 12 inch compacted layer of wood chips, mulch, or gravel. ♦ Sandbags or other erosion control measures shall be installed to prevent silt runoff to public roadways from sites with a slope greater than one percent. ♦ During renovation and demolition activities, removal or disturbance of any materials containing asbestos or other hazardous pollutants will be conducted in accordance with the BAAQMD rules and regulations. ♦ Remediation activities will be conducted in accordance with BAAQMD rules and regulations. Mitigation to Reduce NOx Emissions ♦ The project shall develop a plan for approval by the County or BAAQMD demonstrating that the heavy-duty (>50 horsepower) off-road vehicles to be used in the construction project, including owned, leased and subcontractor vehicles, will achieve a project wide fleet-average 20 percent NOx reduction and 45 percent particulate reduction compared to the most recent CARB fleet average for the year 2010. ♦ At least 80-percent of the equipment that will be used on site for 40 hours or greater shall meet current Tier 3 engine standards. ♦ The project applicant shall require the project developer or contractor to submit to the County or BAAQMD a comprehensive inventory of all off-road construction equipment, equal to or greater than 50 horsepower, that will be used an aggregate of 40 or more hours during any portion of the construction project. The inventory shall include the horsepower rating, engine production year, and projected hours of use or fuel throughput for each piece of equipment. The inventory shall be updated and submitted monthly throughout the duration of the remediation and grading (fill import and grading) phase of the project, except that an	contracts. County to be informed of designated Disturbance Coordinator.		Public Works prior to issuance of grading and building permits. During construction, Building Dept. and/or Dept. of Public Works shall conduct periodic inspections to determine compliance with BAAQMD measures.	

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
inventory shall not be required for any 30-day period in which little or no construction activity occurs. ♦ Opacity is an indicator of exhaust particulate emissions from off-road diesel powered equipment. The project shall ensure that emissions from all construction diesel powered equipment used on the project site do not exceed 40 percent opacity for more than three minutes in any one hour. Any equipment found to exceed 40 percent opacity (or Ringelmann 2.0) shall be repaired immediately. ♦ Diesel equipment standing idle for more than three minutes shall be turned off. This would include trucks waiting to deliver or receive soil, aggregate, or other bulk materials. Rotating drum concrete trucks could keep their engines running continuously as long as they were on-site and away from any residences. Clear signage indicating such idling restrictions shall be posted at construction site access points. ♦ Consider alternative sites and methods to import fill material to the site to reduce NOx emissions. Alternative methods could include use of tug boats or trucks with newer engines that meet recent EPA emissions standards that result in lower emissions. The applicant shall provide an analysis of such alternatives, along with a calculation of emissions for each method. The analysis shall demonstrate that NOx emissions from remediation activities under Option C shall not exceed 15 tons/year. The County shall use this information to determine the acceptable method for importing fill material to the site. This may include a mix of methods and fill sites. ♦ Planned construction activities on Spare the Air days shall be reduced to lower emissions. An attempt to reduce emissions, possibly below 54 pounds per day, would be made for each day that the BAAQMD forecasts a "Spare the Air Day" at least 24 hours prior. The County shall be provided a record of attempts to reduce NOx emissions when Spare the Air Days were forecasted at least 24 hours prior. ♦ Designate a Disturbance Coordinator during construction activities. This coordinator will ensure that all air quality mitigation measures are enforced. In addition, the Disturbance Coordinator will respond to complaints from the public regarding air quality issues (e.g. dust and odors) within 48 hours. The contact information for this Coordinator shall be posted in plain view at the project site. A phone number for the Air District shall also be posted to ensure compliance with applicable regulations. Implementation of Mitigation Measure TRA-14 would require a construction management plan to avoid traffic congestion and specify truck routes.				

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
AQ-3: The project applicant shall reduce air pollutant ROG, NO_x, PM_{10}, and PM_2 emissions from both traffic trips and area sources through the measures listed below. ♦ Bicycle amenities shall be provided for the project. This would include secure bicycle parking for retail employees, bicycle racks for retail customers, bicycle lockers, and bike lane connections. This vehicle trip reduction measure could reduce emissions by an additional 0.5 percent. ♦ Pedestrian facilities shall include easy access and signage to bus stops and roadways that serve the major site uses (e.g. retail and residential uses). This may reduce emissions by an additional 0.5 percent. ♦ Project site employers shall be required to promote transit use by providing transit information and incentives to employees. This measure may reduce emissions by about 0.5 percent. ♦ Provide exterior electrical outlets to encourage use of electrical landscape equipment at retail and residential uses. ♦ Prohibit idling of trucks at loading docks for more than five minutes and include signage indicating such a prohibition. ♦ Provide 110- and 220-volt electrical outlets at loading docks. ♦ Implement a landscape plan that provides shade trees along pedestrian pathways. ♦ Obtain LEED certification or achieve equivalent energy efficiency for new residential and commercial buildings, which would reduce the future energy demand caused by the project. ♦ Implementation of Mitigation Measure TRA-1b would require that the project applicant establish a transportation demand management (TDM) program which shall be funded and administered by the property owners association with the goal of reducing the forecasted auto trip generation from the project by 15 percent. ♦ The effectiveness of these required measures shall be monitored on a biannual basis, and traffic counts will be conducted to determine if the 15 percent reduction of forecasted traffic levels is being achieved. If additional measures are necessary to achieve the 15 percent reduction, the TDM coordinator shall implement other measures to enhance the TDM program. ♦ Implementation of Mitigation Measure TRA-17 would reroute the VINE Route #10 bus so that it would serve the proposed project's transit center. ♦ The Napa County Regional Park and Open Space District is in the process of obtaining permits for a 4,000-plus linear foot segment of trail completing the connection between the project site and the City of American Canyon. This segment of the trail is not on the project site. The cost of constructing this segment is estimated to be $350,000. Prior to occupancy of the project, the applicant shall contribute its fair share towards the cost of constructing this segment of the trail.	Project Applicant and successors in interest shall be responsible for implementing mitigation measure as stated. Deeds conveying property shall reference required mitigations of retailers and employers.	Planning Dept.	Required site measures shall be set forth in approved Design Guidelines and site plan prior to construction. Fair share payment to be made prior to issuance of Certificates of Occupancy.	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
Even with mitigation measures imposed, this impact remains significant and unavoidable.				
AQ-4: To lessen air quality nuisances from exposure to adjacent heavy industrial uses, the following measures shall be implemented prior to construction of new residences near barge loading/unloading areas: ♦ Prior to occupation of the project by sensitive receptors (e.g. residents), the applicant will develop a detailed site plan that includes features to reduce dust nuisance exposures to future project residences located near industrial activities. These features shall include the following: ♦ Wind break in the form of mature trees with sufficient density to reduce wind flow. BAAQMD recommends consideration of tiered plantings of trees such as redwood, deodar cedar, and live oak to reduce TAC and PM exposure. ♦ Buffers to avoid placement of residences near or adjacent to active or planned active industrial uses. Adequate buffers shall be determined through site-specific studies that take into account designs for new residences and anticipated future industrial activities or establish a 200-foot buffer. ♦ Install and maintain air filtration systems of fresh air supply either on an individual unit-by-unit basis, with individual air intake and exhaust ducts ventilating each unit separately, or through a centralized building ventilation system. The ventilation system should be certified to achieve a certain effectiveness, for example, to remove at least 80 percent of ambient PM25 concentrations from indoor areas. The air intake for these units shall be located away from areas producing the air pollution (i.e. toward the south). ♦ Require rerouting of nearby heavy-duty truck routes. ♦ Enforce illegal parking and/or idling of heavy-duty diesel trucks in the vicinity.	Project Applicant is responsible for implementing this mitigation measure as stated.	Planning Dept.	Planning Dept. approves site plan incorporating mitigation measures as stated prior to issuance of residential building permits.	
AQ-5: The County shall review plans for new restaurants in neighborhoods with residences to ensure that these uses install kitchen exhaust vents in accordance with accepted engineering practice, and shall install exhaust filtration systems or other accepted methods of odor reduction.	Project applicant or successors in interest to implement mitigation measure as stated.	Planning Dept.	Measures to be confirmed prior to issuance of restaurant building permits.	
GREENHOUSE GAS EMISSIONS				
GHG-1a: To lessen GHG emissions associated with the project, as part of phase one the applicant shall construct and lease retail space to an on-site market that also sells fresh, locally grown produce. The applicant shall provide for rental subsidies if needed to ensure long term tenancy of a market providing on-site access to fresh food, thereby reducing VMT for project site residents and from food distributors. Even with mitigation measures imposed, this impact remains significant and unavoidable.	Project applicant is responsible for implementing mitigation measure as stated.	Planning Dept.	Prior to issuance of Certificates of Occupancy for Phase I.	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
GHG-1b: The applicant shall provide long term funding for marketing proposed housing units to members of the local workforce and shall market units to businesses in the project vicinity (for employee housing). Both marketing programs shall include a monitoring component to measure their effectiveness and shall be adjusted as needed to maximize the sale and lease of housing units to members of the local workforce for a period of time to be determined by the County and developer.	Project Applicant is responsible for implementing mitigation measure as stated.	County Dept. of Housing and Intergovernmental Cooperation.	County to approve funding and marketing program prior to issuance of Certificates of Occupancy for each Phase.	
GHG-1c: As a means of reducing global warming related impacts of a project, the project applicant shall incorporate additional measures to reduce the project's contribution to the countywide GHG emissions associated with development assumed under the County's General Plan. Such measures shall include the following additional items from the California Attorney General's Office (2008) list of suggested measures for reducing global warming related impacts of a project: *Energy Efficiency* ♦ Design buildings to meet LEED certification requirements applicable as of the project approval date. ♦ Install light colored "cool" roofs and cool pavements. ♦ Install efficient lighting in all buildings (including residential). Also install lighting control systems, where practical. Use daylight as an integral part of lighting systems in all buildings. ♦ Install light emitting diodes (LEDs) or other high efficiency lighting for traffic, street and other outdoor lighting. ♦ Limit the hours of operation or provide minimally acceptable light intensities for outdoor lighting. *Water Conservation and Efficiency* ♦ Design buildings and lots to be water-efficient. Only install water-efficient fixtures and appliances. ♦ Restrict watering methods (e.g., prohibit systems that apply water to non-vegetated surfaces) and control runoff. Prohibit businesses from using pressure washers for cleaning driveways, parking lots, sidewalks, and street surfaces unless required to mitigate health and safety concerns. These restrictions shall be included in the Covenants, Conditions, and Restrictions of the community. *Solid Waste Measures* ♦ Reuse and recycle construction and demolition waste (including, but not limited to, soil, vegetation, concrete, lumber, metal, and cardboard). ♦ Provide interior and exterior storage areas for recyclables and green waste at all buildings. ♦ Provide adequate recycling containers in public areas, including parks, school grounds, paseos, and pedestrian zones in areas of mixed-use development. *Transportation and Motor Vehicles*	Project Applicant implements mitigation measures as stated. Requirements to be contained in Design Guidelines, Building Plans, Site Plan and Subdivision Maps, and Association Conditions, Covenants and Restrictions as appropriate.	Planning Dept.; Dept. of Public Works; County Counsel.	Required measures shall be included in referenced documents prior to approvals by listed departments, and confirmed during required inspections.	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
♦ Promote ride sharing programs at employment centers (e.g., by designating a certain percentage of parking spaces for ride sharing vehicles, designating adequate passenger loading and unloading zones and waiting areas for ride share vehicles, and providing a web site or message board for coordinating ride sharing). ♦ At commercial land uses, all forklifts, "yard trucks," or vehicles that are predominately used on-site at non-residential land uses shall be electric-powered or powered by biofuels (such as biodiesel [B100]) that are produced from waste products, or shall use other technologies that do not rely on direct fossil fuel consumption. ♦ At commercial land uses, limit idling time for commercial vehicles, including delivery and construction vehicles. ♦ Promote the use of alternative fuel vehicles and neighborhood electric vehicle programs through prioritized parking within new commercial and retail areas for electric vehicles, hybrid vehicles, and alternative fuel vehicles. ♦ Provide shuttle service from mixed-use and employment areas to public transit. ♦ Provide information on all options for individuals and businesses to reduce transportation-related emissions, including education and information about public transportation. ♦ Provide bicycle parking near building entrances to promote cyclist safety, security and convenience. ♦ Provide secure bicycle storage at public garage parking facilities. ♦ Locate facilities and infrastructure in all land use types to encourage the use of low or zero emission vehicles (e.g. electric vehicle charging facilities and conveniently located alternative fueling stations). *Performance Standard* ♦ Demonstrate that, by implementation of the measures set forth above, the project achieves a reduction of greenhouse gas emissions, as compared to "Business As Usual," consistent with the target stipulated in the County's Climate Change Action Plan as adopted by the BOS on or before approval of the project. Incorporate additional measures, such as the installation of solar power or other renewable energy systems, if necessary to ensure this target is achieved.				
HAZARDS AND HAZARDOUS MATERIALS				
HAZ-1: To lessen the risk of exposure related to accidental release of hazardous materials during cleanup, construction and operation phases of the project, the project applicant shall fully implement the provisions of the RAP and RDIP including but not limited to the soil risk management protocols in the RDIP that address discovery of new or different contamination during earth-working and subsurface construction activities. As outlined in the RAP, such implementation would include multiple dust control strategies that would be employed during remediation. A water mist would be applied to the excavation and	Project Applicant is responsible for implementing mitigation measure as stated.	Planning Dept.; County Counsel re Deed Restriction	Planning Dept. confirms measures as stated.	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
soil handling area and all truck haul routes, while the soil itself would be wetted, to reduce airborne dust generation. In addition, intermittent air monitoring would be conducted in accordance with local air quality management regulations, and equipment used to excavate, transport and manage soil would be decontaminated through a process of brushing and washing in a central decontamination area. In conjunction with amending the Site 1 WDRs, prepare and record a deed restriction acceptable to the RWQCB that ensures that no buildings are constructed on the WMU in a fashion that impairs access or functioning of the collection trench and drainage system, and that provides access for inspections and maintenance of a collection trench/drainage system sufficient to comply with the Site 1 WDRs.				
HAZ-2: The applicant shall carry out the provisions set forth in the RAP and clean up the site to levels below the levels protective of human health and the environment agreed to by the RWQCB. Following full implementation, the applicant shall prepare and submit a report to the San Francisco Bay RWQCB for review and approval. The report shall document cleanup activities performed, quantities of soil reused on-site and disposed of off-site, facilities that received exported material, soil gas sample analytical results, and verification that the targeted cleanup levels have been achieved.	Project Applicant is responsible for implementing mitigation measure as stated.	Planning Dept.	Planning Dept. confirms in conjunction with required approvals and inspections.	
HAZ-3: To allow for the successful assessment and remediation of any previously unknown soil contaminants hazardous to the public and/or environment encountered during project construction, implement the protocols documented in the soil risk management plan portion of the RDIP in the event that such contaminants are encountered, and record in the deed records for the site a notice of the existence of the soil risk management protocols from the RDIP (including a full copy of those protocols) so that all owners of portions of the site have advanced notice of both the existence of the soil risk management plan and its terms and provisions.	Project Applicant is responsible for implementing mitigation measure as stated.	Dept. of Public Works; County Counsel.	County Counsel to review and approve deeds prior to recordation to ensure notice of required protocols; Dept. of Public Works to ensure compliance during grading inspections.	
GEOLOGY, SOILS, AND SEISMICITY				
GEO-1: To lessen potential damage from strong or violent ground shaking, prior to the issuance of permits for the construction of infrastructure, buildings and bridges, the applicant's geotechnical engineer shall prepare and submit to the County for review geotechnical reports incorporating the specific mitigation of seismic hazards pursuant to State law, as detailed in the California Building Code, and as required by the County of Napa to ensure that structures and infrastructure can withstand ground accelerations expected from seismic activity. The improvement plans shall incorporate all design and construction criteria specified in the report(s). The geotechnical engineer shall sign the improvement plans and approve them as conforming to their recommendations prior to parcel/final map approval. The project geotechnical engineer shall provide geotechnical observation during the construction, which will allow the geotechnical engineer to compare the actual	Project Applicant is responsible for implementing mitigation measure as stated. Retention of geotechnical engineer is subject to County approval.	Dept. of Public Works, Planning Dept.	Confirmation of recommendations in improvement plans by Dept. of Public Works prior to parcel/final map approval, and in building plans prior to approval by Planning Dept. Conformance to rec-	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
with the anticipated soil conditions and to check that the contractor's work conforms to the geotechnical aspects of the plans and specifications. The geotechnical engineer of record will prepare letters and as-built documents, to be submitted to the County, to document their observances during construction and to document that the work performed is in accordance with the project plans and specifications.			ommendations and engineers reports to occur during required County inspections.	
GEO-2: To lessen potential damage from liquefaction, the recommendations for both special foundations and other geotechnical engineering measures specified in the applicant's geotechnical reports (prepared by T&R, dated January 23, 2007 and May 21, 2007) shall be implemented during design and construction. These measures include engineering and compaction of new fills, removal or improvement of potentially liquefiable soils and compressible soils, and use of deep foundations. Documentation of the methods used shall be provided in the required design-level geotechnical report(s).	Project Applicant is responsible for implementing mitigation measure as stated.	Dept. of Public Works, Planning Dept.	Confirmation of inclusion of recommendations prior to issuance of grading/building permits. Conformance to recommendations and engineers reports to occur during required County inspections.	
GEO-3: Lateral spreading during potential future earthquakes shall be mitigated by correcting the liquefaction hazard to which it is related. Corrective measures, which shall be included in the required design-level geotechnical report(s), shall include: ♦ Engineering and compaction of new fills. ♦ Removal or densification of liquefiable soils. ♦ Use of relatively rigid foundations.	Project Applicant is responsible for implementing mitigation measure as stated.	Dept. of Public Works, Planning Dept.	Confirmation of inclusion of recommendations prior to issuance of grading/building permits. Conformance to recommendations and engineers reports to occur during required County inspections.	
GEO-4: To avoid excessive settlement that could cause damage to foundations and pavements, poorly compacted fills shall be mitigated by excavation and/or additional compaction. Options to mitigate these effects include implementing a surcharge program, supporting structures with deep foundations that include drilled or driven piles and installing flexible connections for utilities. The geotechnical recommendations for mitigation of existing and proposed fills, and for settlement of native soils, that are contained in the applicant's geotechnical reports shall be implemented. These measures include removal and recompaction of pre-existing loose fills, and proper engineering and compaction of all new fills.	Project Applicant is responsible for implementing mitigation measure as stated.	Dept. of Public Works.	Confirmation of inclusion of recommendations prior to issuance of grading. Conformance to recommendations and engineers reports to occur during required County inspections.	
GEO-5: As a part of final design, the project geotechnical engineer shall make specific recommendations to minimize or eliminate expansive soils under pavements and structures. Such measures for buildings may include use of appropriate foundations, by cap-	Project Applicant is responsible for implementing mitiga-	Planning Dept.	Confirmation of inclusion of recommendations prior	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
ping expansive soils with a layer of no-expansive fill, or by lime treatment. Such measures for pavements may include special pavement design and/or subexcavation of expansive soils. These recommendations shall be based on testing of the in-site fill materials. The recommendation measures shall be submitted to the County as a part of building and/or paving plan submittal prior to the issuance of building/construction permits.	tion measure as stated.		to issuance of building permits. Conformance to recommendations and engineers reports to occur during required County inspections.	
HYDROLOGY AND WATER QUALITY				
HYDRO-3: Before the approval of grading plans and building permits, the project applicant(s) for all project phases shall submit final drainage plans to the County demonstrating that off-site upstream runoff would be appropriately conveyed through the project site, and that project-related on-site runoff would be appropriately detained to reduce flooding impacts. The plans shall adhere to the guidelines and requirements set forth for drainage in the Napa County Road & Street Standards. Design of BMPs for flood control shall comply with all regulations and be approved by the County.	Project Applicant shall implement mitigation measure as stated.	Dept. of Public Works.	Final drainage plans to be submitted and approved prior to issuance of any grading/building permits.	
HYDRO-4: Prior to approval of grading permits and improvement plans (for each project phase), the project applicant shall prepare and submit an Erosion and Sediment Control Plan (ESCP) for review and approval by the County. The ESCP shall include the locations and descriptions of control measures (BMPs), such as straw bale barriers, straw mulching, straw wattles, silt fencing, and temporary sediment ponds to be used at the project site to control and manage erosion and sediment, control and treat runoff, and promote infiltration of runoff from new impervious surfaces. The Applicant shall also submit a Notice of Intent (NOI) to the State Water Resources Control Board for coverage under the NPDES Construction General Permit and prepare and submit a Storm Water Pollution Prevention Plan (SWPPP) for review and approval by the County prior to issuance of a grading permit. The SWPPP shall incorporate the ESCP and describe construction-phase housekeeping measures, such as spill prevention and cleanup measures, means of waste disposal, and best management practices training for on-site workers. The SWPPP shall incorporate the monitoring requirements and other provisions in the recently updated SWRCB General Permit for Construction Activities (approved September 2, 2009). A Stormwater Runoff Management Plan (SRMP) shall also be prepared for review and approval by the County, as specified in the Napa County Post-Construction Runoff Management Requirements. The SRMP shall include descriptions and designs of the post-construction BMPs to be implemented, such as bioswales, biofiltration features and stormwater retention basins, well as non-structural BMPs, such as street sweeping and covered waste disposal areas. The SRMP shall also prescribe monitoring and maintenance practices for the BMPs to maintain treatment effectiveness. Where applicable, these BMPs shall be designed based on specific criteria from recognized BMP design guid-	Project Applicant shall implement mitigation measure as stated.	Dept. of Public Works.	ESCP, SWPPP, and SRMP shall be reviewed and approved prior to issuance of grading permits for each phase.	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
ance manuals, such as the California BMP Handbooks (available at www.napastormwater.org).				
HYDRO-5**:** Prior to beginning of construction of the project, the applicant shall abandon all existing wells on the project site that are not planned for water supply or groundwater monitoring consistent with Napa County Environmental Health standards and the standards described in State of California Bulletin 74-81 (Water Well Standards).	Project Applicant shall implement mitigation measure as stated.	Dept. of Environmental Management.	Prior to issuance of grading/building permits.	
HYDRO-6: Prior to approval of the final grading plan, the project shall submit a request for a Conditional Letter of Map Revision (CLOMR) for review and action by FEMA and/or their designated representative in order to remove the elevated parcels from the SFHA. With the approved CLOMR and placement of fill as described, the project shall submit a request for a Letter of Map Revision (LOMR).	Project Applicant shall implement mitigation measure as stated.	Department of Public Works	Dept. of Public Works shall confirm approved CLOMR prior to approval of grading plans and issuance of grading permits.	
HYDRO-7a: The project proponents shall construct floodgates at either end of the railroad ROW as described in the PWA memorandum. Operation and maintenance of the floodgates shall be established in an agreement authorized and approved by the Napa County Office of Emergency Services, (NCOES) and shall be the responsibility of the Home Owners Association (HOA) or such other responsible legal entity as determined in agreement with the NCOES.	Project Applicant shall implement mitigation measure as stated.	Dept. of Public Works, Napa County Office of Emergency Services	Construction of floodgates and approval of operation/maintenance agreement prior to issuance of building permits.	
HYDRO-7b: While the floodgates will provide protection for the area between them, the wetland area to the south and the adjacent park areas would remain vulnerable to potential flooding, as would the northwest park area of the project site. The project proponents shall provide adequate public signage in the nature area and wetland, and northwest park warning park patrons of the potential flood hazard.	Project Applicant shall implement mitigation measure as stated.	Dept. of Public Works.	Adequate signage shall be confirmed prior to issuance of Certificates of Occupancy.	
CULTURAL RESOURCES				
CULT-1a: Prior to the demolition of buildings and structures comprising the Basalt Shipyard District, the District shall be documented to the Historic American Buildings Survey (HABS) documentation level III, as follows: Documentation Level III 1. Drawings: sketch plan. 2. Photographs: photographs with large-format negatives of exterior and interior views. 3. Written data: architectural data form. Documentation shall be completed by a qualified architectural historian and shall include large-format photography and historical documentation. These documents shall be provided to the Napa County Historical Society and to the Napa County Library, assuring that the public has access to the record of this historic resource.	Project Applicant shall implement mitigation measure as stated. County to approve qualified architectural historian and report submittal	Planning Dept.	Prior to issuance of demolition permits.	

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
CULT-1b: An interpretive display featuring the shipyard's history shall be incorporated into the project. This display shall be located in an area accessible to the public and shall provide information regarding the historical contributions of the Basalt Shipyard. The display will help to place the dry docks in context for the public.	Project Applicant shall implement mitigation measure as stated.	Planning Dept.	Prior to issuance of certificates of occupancy	
CULT-2: To prevent damage to previously identified archaeological resources, prior to any excavation on-site, an archaeologist shall review excavation plans in areas identified as archaeologically/geologically sensitive and shall develop a monitoring plan based on depth of the excavation and data from boring logs. The plan shall include observation of ground disturbing activities (such as grading, trenching and boring) to be focused in areas that are most likely to contain buried resources (see Figure 4.11-1 of 2009 DEIR). The archaeologist shall limit on-site monitoring to only areas where depth of excavation and information from boring logs suggests that sensitive resources may be encountered. In addition, project personnel shall be made aware of the types of materials that denote possible archaeological sites. If archaeological materials are discovered accidentally during the course of construction, all work within 50 feet of the find shall stop while an assessment of the find is made by an archaeologist who is called in. If needed, a treatment plan shall be developed that takes into account the nature and scope of the find. This could range in complexity from a relatively brief investigation of a scatter of lithic materials, to a far more extensive recovery of human remains.	Project Applicant shall implement mitigation measure as stated, and require adherence by contractors. County shall approve of retained archaeologist.	Planning Dept., Public Works Department	Plan to be approved by County prior to issuance of grading permits. Compliance with plan to be monitored during County inspections.	
CULT-3: If paleontological deposits are discovered, all work within 50 feet of the find shall stop until a geologist who is called in can determine its significance. Specific recommendations for the treatment of paleontological materials would depend on the nature of the discovery and could range from brief investigation of a limited deposit of invertebrate remains to more extensive exposure and removal of large vertebrate fossils.	Project Applicant shall implement mitigation measure as stated, and require adherence by contractors.	Planning Dept., Dept. of Public Works.	Compliance with mitigation measure to be monitored during County inspections.	
CULT-4: Project personnel shall be briefed in the proper procedures to follow in the event that human remains are encountered during construction and an archaeologist is not on-site. If human remains are discovered by an archaeologist or by project personnel, all work shall stop within 50 feet of the find and the Napa County Coroner shall be notified. If it is determined that the remains are those of a prehistoric Native American, the Coroner shall notify the Native American Heritage Commission, which will identify the Most Likely Descendent to provide tribal recommendations regarding the disposition of the remains. To the extent feasible and reasonable, recommendations of the Most Likely Descendent shall be implemented.	Project Applicant shall implement mitigation measure as stated, and require adherence by contractors.	Planning Dept., County Coroner.	Compliance with mitigation measure to be monitored during County inspections.	
PUBLIC SERVICES AND RECREATION				
PS-1: In order to ensure adequate law enforcement staff and equipment, the County shall prepare an updated fiscal analysis prior to or concurrent with the approval of design guidelines. If the updated analysis shows a shortfall in revenue on an interim or long-term basis, then:	Project Applicant and County implement mitigation measure as stated.	Planning Dept., Napa County Sheriff's Department.	If needed, financing mechanism in place prior to, or concurrent with,	

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Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
1. Prior to, or concurrent with, the approval of the design guidelines, the County and the applicant shall identify and implement a financing mechanism to supplement expected property tax, sales tax, and other sources of revenues to provide sufficient funding for ongoing costs associated with law enforcement services at the Napa Pipe site. The County shall also require the applicant to provide an adequate level of interim financing for law enforcement services between project approval and when funding becomes available from the financing mechanism, property taxes, sales taxes, and other sources of revenue. 2. Prior to initiation of construction, the County and Project Applicant shall consult with law enforcement personnel within the City of Napa as provided for by General Plan Policy SAF-34, and shall seek to renegotiate the terms of the automatic Mutual Aid Agreement between Napa City Police Department (NCPD) and Napa County Sheriffs' Department (NCSD) to address concerns of each agency regarding potential increases in service calls.			approval of design guidelines. NCPD and NCSD negotiations re Mutual Aid Agreement to occur prior to initiation of construction.	
PS-2: In order to ensure adequate staff and equipment for fire services, the County shall prepare an updated fiscal analysis prior to or concurrent with approval of design guidelines. If the updated analysis shows a shortfall in revenue on an interim or long-term basis, then: 1. The County and the applicant shall identify and implement a financing mechanism if necessary to supplement expected property tax, sales tax, and other sources of revenues to fund increased fire protection services provided at the Napa Pipe site. The County shall also require the applicant to provide an adequate level of interim financing for fire services between project approval and when funding becomes available from the financing mechanism, property taxes, sales taxes, and other sources of revenue. 2. The County shall seek to renegotiate the terms of the automatic Mutual Aid Agreement between NCFD and the City of Napa Fire Department to address concerns of each agency regarding increases in service calls.	Project Applicant and County implement mitigation measure as stated.	Planning Dept., Napa County Fire Department.	If needed, financing mechanism in place prior to, or concurrent with, approval of design guidelines. NCFD and City of Napa Fire Department negotiations re Mutual Aid Agreement to occur prior to issuance of certificates of occupancy.	
PS-4: In order to ensure that adequate library services are provided, the County shall shall prepare an updated fiscal analysis prior to concurrent with approval of design guidelines. If the updated analysis shows a shortfall in revenue on an interim or long-term basis, then: 1. The County and the applicant shall identify and implement a financing mechanism if necessary to supplement expected property tax, sales tax, and other sources of revenues to fund increased library services needed to serve Napa Pipe residents. The County shall also require the applicant to provide an adequate level of interim financing, if necessary, between project approval and when funding becomes available from the financing mechanism, property taxes, sales taxes, and other sources of revenue.	County and Applicant shall implement mitigation measure as stated.	Planning Dept.	If needed, financing mechanism in place prior to, or concurrent with, approval of design guidelines.	

Mitigation Measures[1]	Implementation Procedure	Monitoring Responsibility	Monitoring / Reporting Action and Schedule	Monitoring Compliance Record (Name/Date)
UTILITIES				
UTIL-1: The project applicant shall pay connection fees and sewer service charges to the Napa Sanitation District (NSD) in compliance with the NSD's Sewer Use Ordinance in effect at the time the building permit is issued for each structure. Additionally, the project applicant shall be responsible for the costs associated with the planned improvements as described in the 2011 studies by NSD, or as may need to be revised based on the level of approved development. These studies determined the mid-range density alternative project impacts on the District's collection, treatment, and water recycling systems resulting from the additional flow and loading from the portion of the project that exceeds the current County General Plan and are included in FEIR Appendix N. All costs associated with the mitigations of these impacts must be paid for by the project applicant. Before the final map for the project is recorded, the applicant and NSD shall prepare and execute an agreement defining the design and construction schedule, scope and estimated cost of the planned improvements. The applicant shall make payment in a manner such that funds are provided to NSD when they are needed to implement the projects.	Project Applicant implements mitigation measures as stated.	Planning Dept.	Project Applicant provides proof to Planning Dept. of payment of fee at time of building permit issuance.	
UTIL-3: If the City of Napa agrees to provide potable water to the project, the applicant shall: • fund an updated study by the City's Water Department (if needed) to confirm that the storage, treatment, and pumping facilities identified in 2008 are no longer needed and that construction of an expanded pipeline south of the site is the only infrastructure improvement required for service; • if it is determined that off-site infrastructure improvements are necessary, construct or fund construction to the City's specifications.	Project Applicant shall work with City of Napa to implement mitigation measure as stated.	Planning Dept.	Project Applicant shall conduct negotiations with City of Napa and determine water provision option prior to recordation of first final subdivision map.	

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WATER

Exhibit S.1 - Water Supply Assessment

The County Board of Supervisors approved the project in June 2013. In approving the project, the County also approved a water supply assessment (revised May 14, 2013), as required under Water Code section 10910 et seq. The revised WSA focuses on the availability of City water supplies to serve the project. The revised WSA includes the following information:

- An estimate of water potable and non-potable water demand associated with the project;

- Information regarding the City of Napa's existing and projected water demand;

- Information regarding the City of Napa's existing and planned water supplies; and

- An assessment of whether the City has adequate water available to meet the potable water demands of the project.

The adopted revised WSA is incorporated by reference.

The revised WSA reaches the following conclusions regarding the availability of sufficient City water supplies to meet the potable water demands from the project:

As described in the preceding sections of this Revised WSA, potable water demands of the Project are projected to be approximately 300 AFY, plus 25 AFY for a potential future school. Non-potable demands will be approximately 150 AFY.

As set forth in Section 6.1, the City's projected water supplies available during normal and multiple dry water years will meet the projected water demands associated with the Project, in addition to the City's existing and planned future uses, including agricultural and manufacturing uses, for the first 20 years of the Project. During those years, delivering water to the Project would not impact the availability of water to other existing or planned future water customers of the City. In fact, the City would experience a substantial surplus of water supplies during those years.

Based on use of only Table A water from the SWP, there is a risk of the City experiencing a water supply deficit during a single dry year, which has an approximately 20 percent chance of occurring during the first 20 years of the Project. However, as described in Section 6.2, the City is likely to have access to SWP supplies other than Table A entitlement that would eliminate or significantly mitigate any water shortage. In particular, carryover water is expected to be available in a single dry year and could potentially eliminate any water supply deficit and create a surplus. In addition, the City would likely be able to acquire dry year supplies through DWR or an independent water transfer. The City has used water from each of these sources in the past to avoid a water shortage, and is likely to do so in the future, either with or without the Project. Based on the likelihood of such supplies being available, it is expected that the City will have sufficient water supplies to serve the Project even in single dry years.

This Revised WSA concludes that the City will have sufficient potable and non-potable water supplies available during normal, single dry and multiple dry water years during a 20-year projection to meet all projected water demands associated with its existing and future customers, including the proposed Project. In addition, the Project will not adversely affect the availability of water for any other use, including agricultural and manufacturing uses.

(Revised WSA, p. 58, fn. omitted.)

The site is already connected to the City's water distribution system. Connection points are located at the northern project entrance on Kaiser and the southern project entrance at Napa Valley Corporate Drive. The applicant and the City have preliminarily determined that necessary improvements will include a twelve inch (12") water supply pipeline connecting the existing Jamieson Transmission Line to the south side of the Property along Anselmo Court. The applicant and the City have agreed that, to the extent these existing connections will be upgraded in order to supply potable water to the site, the project will fund these upgrades.

The applicant and the City have also engaged in extensive discussions regarding connection fees and water rates for potable water delivered to the site. At this time, the applicant and the City have not reached agreement regarding these financial terms. The applicant envisions that these discussions will continue. The applicant is hopeful that that agreement will be reached such that the project will pay its fair share for the cost of connecting to the City's water system, and for water purchasing potable water from the City. The applicant does not expect existing City rate-payers to subsidize the cost of providing water to the site. The applicant also envisions that on-site infrastructure will be constructed to City standards.