Technical Memorandum

April 18, 2023

To	Christopher Drop, General Manager Manila CSD	**Contact No.**	(707) 267-2275
Copy to	Brett Vivyan, PE	**Email**	brett.vivyan@ghd.com
From	Taylor Goodwyn	**Project No.**	12572691
Project Name	Manila Community Services District Flood Reduction and Drainage Enhancement Project		
Subject	Draft Basis of Design Report		

1. Introduction

1.1 Background

Manila is an unincorporated coastal community on the Samoa Peninsula along State Route 255 (SR-255) within Humboldt County, California. Manila CSD is located along coastal Humboldt County, California, encompassing approximately 1,600 acres (Figure 1). The Manila CSD service area is located on the approximately half-mile wide peninsula along the north spit between Humboldt Bay and the dunes. Manila is approximately 3.5 miles directly north of Eureka and approximately five miles southwest of Arcata.

The existing drainage network lacks connectivity and sufficient capacity with single purpose fixes scattered throughout the community, without consideration of each system's reliance on the functioning of other systems owned by Manila CSD, the County of Humboldt, the North Coast Rail Authority, Caltrans, and private properties. Winter rains and shallow ground water overwhelm the existing drainage system, resulting in widespread flooding of roadways, residences, and public spaces within this severely disadvantaged community. Manila has been afflicted with chronic flooding every winter for decades. In many locations surrounding local roads and homes, there is no planned drainage whatsoever, contributing to flooding of roadways, driveways, and residences. Culverts are undersized and failing, drainage ditches lack appropriate conveyance capacity. Many drainage paths span multiple jurisdictions, each relying on the capacity and condition of the next downstream reach.

The 1987 Storm Drainage Master Plan by Oscar Larson & Associates (OLA, 1987) identified several recommended projects and background information, that remain relevant. These projects and background information, in addition to field investigations in the Fall of 2018 by Manila CSD, GHD, and Humboldt State University's Capstone Engineering Class provide the basis this community-wide approach to address persistent flooding and drainage problems caused by undersized, disconnected, and failing infrastructure. Simple solutions, consisting of vegetated bioswales, rain gardens, replacement of undersized and failing culverts, and new culverts and stormdrain pipes in select locations are proposed. The project, led by the Manila Community Services District, will incorporate multi-objective, multi-benefit project components that address flood reduction, ecosystem services, and resiliency to sea level rise and climate change. The proposed project provides an opportunity for the Manila Community Services District to coordinate with the County of Humboldt, North Coast

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Rail Authority (NCRA), California Department of Transportation (Caltrans), and private property owners to enhance the community by reducing flooding, providing resiliency to sea level rise and climate change, and enhancing habitat.

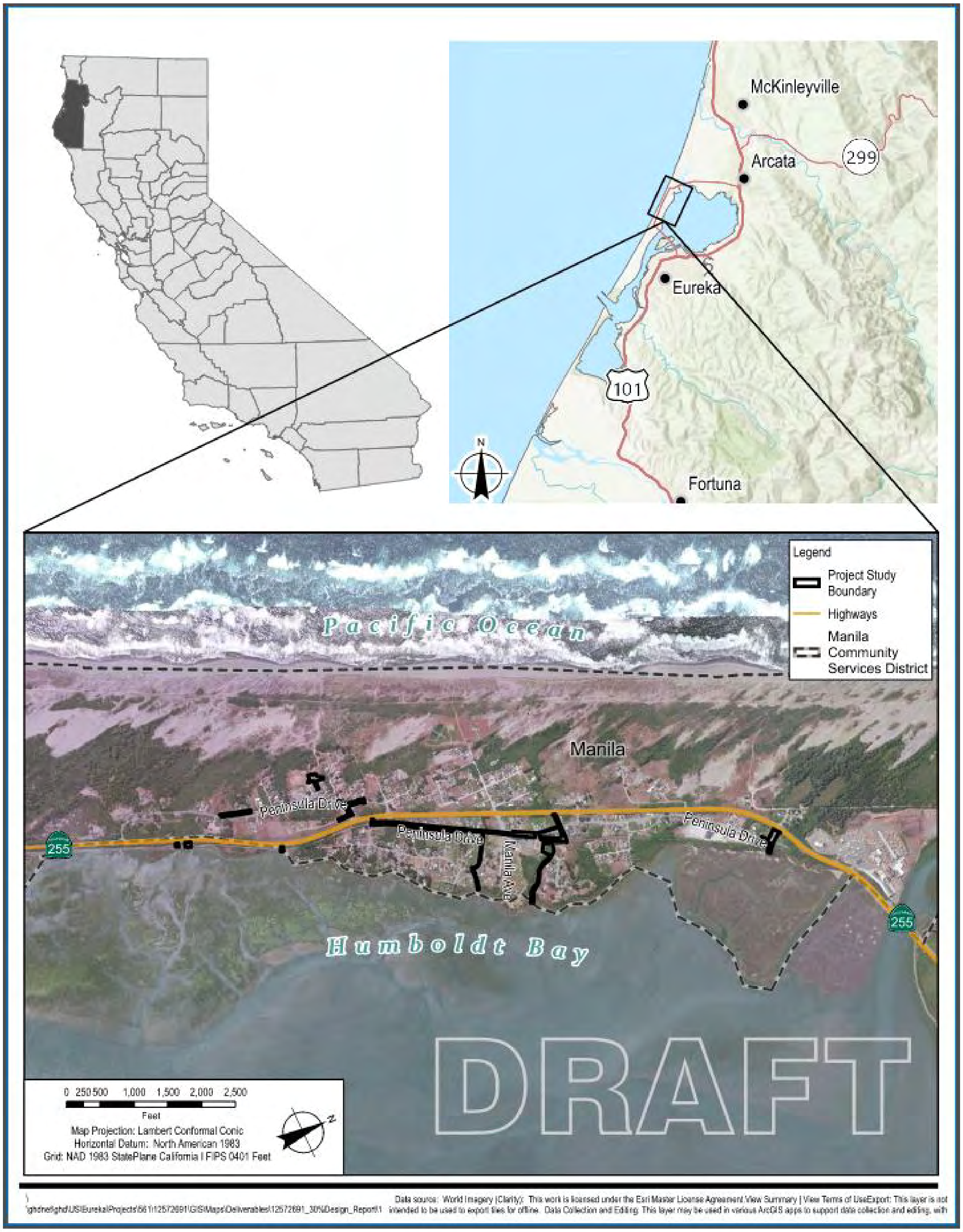

Figure 1-1 Project Vicinity Map

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1.2 Purpose and Scope

Chronic flooding currently impacts Manila residents, pedestrians, and travelers throughout the community, throughout the rainy season. Impacts include persistent roadway and driveway flooding from average rainfall events due to undersized culverts, undersized roadway ditches, and lack of connectivity between facilities. In many locations, roadside drainage facilities are entirely absent, resulting in reduced or closed travel lanes and roadway shoulders and ponding that inhibits access to residences. Roadway flooding and access limitations related to flooding impact mobility through and within Manila and create hazardous conditions for pedestrians and automobiles. Access to public infrastructure such as water meters is inhibited throughout the winter months. Flooding in some areas results in inflow to the Septic Tank Effluent Pump system posing potential risks to septic tank overflows and increasing the cost of pumping and maintaining the wastewater system. Flooding in Manila has become more severe over time as connectivity between the limited existing facilities has diminished and undersized roadside ditches and failing culverts constrain hydraulic capacity. Project components include:

- Bioswales: Debris blockages, sediment aggradation, and woody vegetation within existing bioswale flow paths will be removed along with minor grading to restore historical geometry. New bioswales will be graded to connect existing drainage paths. Banks of existing and new bioswales will be seeded and planted with native species.
- Culvert replacement: existing culverts that are undersized and or failing will be replaced with new, larger capacity culverts. Where existing culverts have flap gates, flap gates will be replaced along with the culvert.
- New culverts and storm drain pipes: new culverts and storm drain pipes will be installed in select locations to connect drainage areas.
- Valley gutters: valley gutters will be installed in select locations to connect bioswales at residential driveway crossings.
- Rain gardens: rain gardens will replace select impervious areas at the Manila Community Center and will be constructed as space allows along the roadway where conveyance to other areas is limited.

2. Design Considerations

2.1 Existing and Projected Study Area Characteristics / Geographical Setting

2.1.1 Climate

The climate in the project area is typified by dry summers and wet winters. The closest weather station is in Eureka, about 3 miles from the project site (NOAA, 2017) According to National Oceanic and Atmospheric Administration (NOAA) National Weather Service, the average rainfall by year in Manila is 39.26 inches with the most active months between October through April. The average precipitation in the project area between the years 2000 – 2022 by month is reported below in Table 1.

Table 1 Average Monthly Precipitation in Manila, CA

Month	Inches of Precipitation
January	6.13
February	5.13
March	5.49

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Month	Inches of Precipitation
April	3.52
May	1.49
June	0.71
July	0.16
August	0.14
September	0.78
October	2.62
November	4.52
December	8.06

2.1.2 Topography

The Project is located on the northern end of the 10-mile peninsula that separates the Pacific Ocean and Humboldt Bay. The peninsula is largely comprised of vegetated and non-vegetated dunes. Distributed within the dune ridges are hollows that bolster wetland habitat. The elevations of infrastructure withing the project area is highest at around 40 feet and lowest at approximately 17 feet.

Human development and alteration of the dune hollows has possibly contributed to the current flood problems afflicting Manila. Low-lying topographic areas (like Manila) naturally have poor drainage characteristics that are sensitive to high ground water levels, in addition to tidal fluctuations near the shoreline. Historic construction of roads, railroads, and land filing has inhibited the natural drainage paths and has likely compounded to present-day flooding (OLA, 1987).

2.1.3 Geology

A Geotechnical Report prepared by Crawford & Associates, Inc provided a detailed analysis of the geology within Manila for the Water Tank Replacement Project. The sandy spit that the project is located on has a sediment composition of Holocene aeolian (wind-blown) deposits underlain by late Pleistocene age marine and non-marine alluvial deposits (CAInc, 2017).

2.1.4 Soils

According to the National Resources Conservation Service's Web Soil Survey (NRCS, 2022), the soils in the project vicinity are composed primarily of *Samoa-Clambeach complex, 0 to 50 percent slopes* mixed sands with low topographic variability. These soils are typified as poorly drained with high to very high saturation and are susceptible to erosion and liquefaction in the event of seismic shaking (NRCS, 2022).

2.1.5 Groundwater

Based on field observations and previous studies, groundwater elevations in Manila vary spatially and temporally. Historical groundwater monitoring wells show up to three feet of variation in groundwater elevation at individual sites and exhibited an overall variation from ground surface to eight feet below ground surface throughout the developed areas (Winzler & Kelly, 1978). This general trend is consistent with more recent field observations in the project area. During moderate rainfall events, rainfall runoff is compounded with elevated groundwater levels and restricted flow paths due to development and failing infrastructure that result in flooded persistently flooded roadways and residences.

2.1.6 Drainage

The drainage pathways within the project vicinity tend to flow in an easterly direction, from the dunes along the western edge of the community to Humboldt Bay. In select areas, runoff accumulates in low-lying areas from multiple directions. The drainage courses include vegetated ditches and culverts, largely adjacent to or crossing roads and railroad tracks. Much of the existing drainage channels have experienced accumulation of sediment and debris. Many culverts have failed or are undersized. The impactions severely restrict the hydraulic conveyance capacity and result in persistent flooding of roadways and residences.

New drainage facilities connecting to existing Caltrans facilities will use a 10-year design storm and evaluate downstream hydraulics as listed in the Caltrans Highway Design Manual Desirable Roadway Drainage Guidelines (Caltrans, 2020). The Humboldt County Low Impact Development Manual (County of Humboldt, 2016) design standards will be adhered to for all LID systems including bioswales and rain garden. The bioswales will adhere to the following design criteria: maximum flow depth between 4”-6”, maximum water velocity of 3 fps, and discharge into a piped system. The rain garden will adhere to the following bioretention facility guidelines: minimum of 18” depth of soil mix under the top of soil layer (TSL), minimum of 12” depth of class 2 permeable gravel under the soil layer, installation of all plantings to maintain TSL, 4” minimum diameter SDR 35 or equivalent sweep bend and cleanout minimum 2” above overflow level, and a concrete drop inlet or manhole with ¼” openings. Due to the surrounding areas highly saturated soil and low infiltration rates, it is recommended that rain gardens have a perforated underdrain system to collect and convey filtered storm water to the storm drain. This is compliant with the guidelines set by the Humboldt County Low Impact Development Manual (County of Humboldt, 2016). A more detailed report of their rain garden design standards is illustrated below in Figure 2.

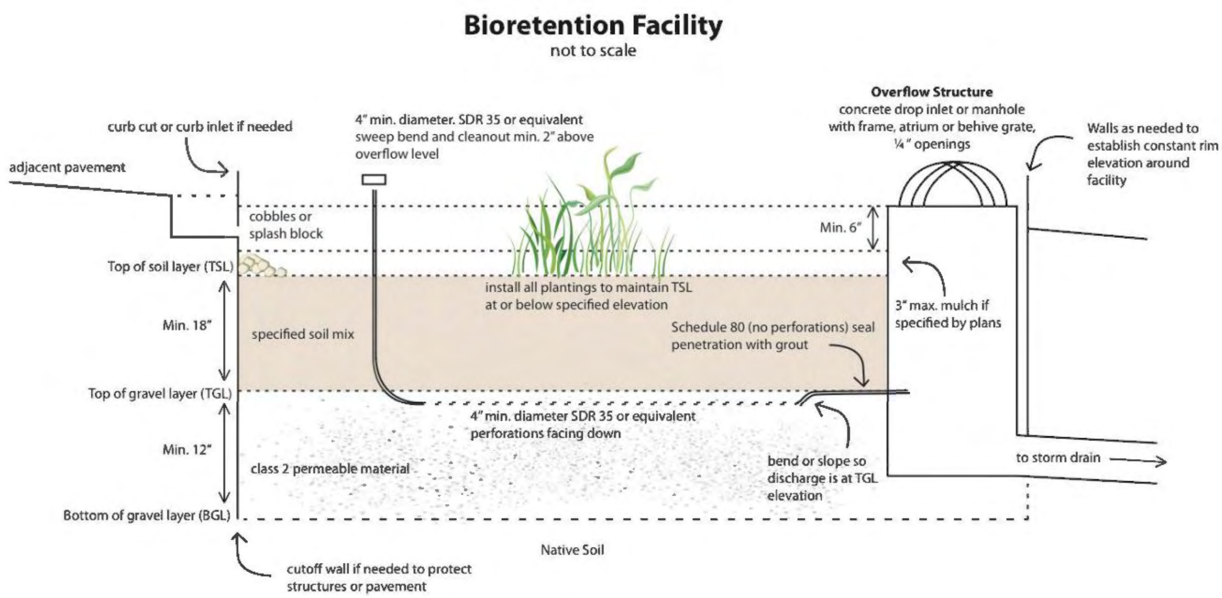

Figure 2-1: ***Humboldt County Low Impact Development Manual Bioretention Facility Design Standards (County of Humboldt, 2016)***

The Federal Emergency Management Agency (FEMA) delineates regional flooding hazards as part of the National Flood Insurance Program and includes areas adjacent to Manila. Drainage infrastructure within the project area includes select areas that generally between elevations 17 to 40 feet. The most recent Flood Insurance Rate Map (FIRM) Panel 06023C0830F, encompassing the planning area, became effective on November 4, 2016. The FIRM indicates that much of the project area is located within Zone X, which is defined as areas outside the 0.2% annual chance floodplain. Select low-elevation locations along Humboldt Bay are within Zone A. The Flood Insurance Study for Humboldt County, California and Incorporated Areas identifies an elevation of 9.67 feet (NAVD88) for the 1% annual chance stillwater elevation for Humboldt Bay at Eureka and King Salmon.

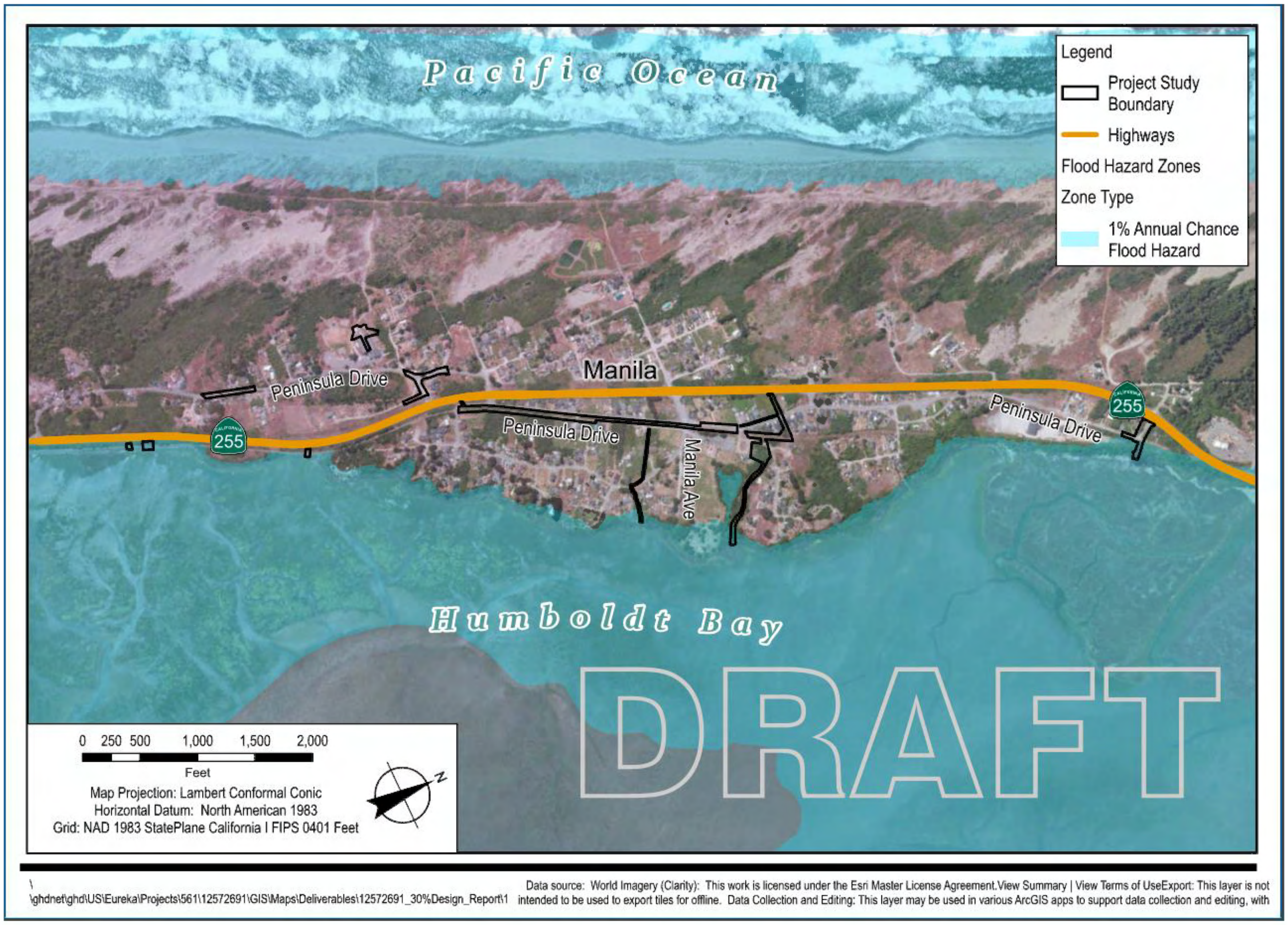

Figure 2-2 Project Vicinity Special Flood Hazard Areas

2.2 Land Use Classification

2.2.1 Existing Land Use

The current land use within the project area is majorly low-density residential and natural resources (OLA, 1987). The designated land-use within the project area includes the following: residential single family, rural residential agriculture, public facility, public recreation, railroad yards, unimproved zones, general commercial, general industrial, and natural resources including dune and wetland areas.

2.2.2 Future Land Use

Population trends reported in the Humboldt County General Plan (Dyett & Bhatia, 2002), indicate that Humboldt County experienced 16.6 percent growth from 1980 to 2000 (0.83 percent annual), and projected 11.5 percent growth from 2000 to 2020 (0.58 percent annual). However, the growth in Manila is likely slightly less than the County as a whole and could be more on the order of 0.5% per year. Over a twenty-year planning horizon, a 0.5% annual growth rate over a base population of 780 results in a forecasted population of 860. Future land use is expected to remain similar to existing, as limited space is available for additional development.

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2.3 Hydrology

2.3.1 Rational Method

The rational method is one of the most common methods for computing urban storm water runoff quantities. It is a peak discharge method that considers local conditions and relates surface runoff directly to rainfall as expressed in the following equation (Viessman & Lewis, 1995):

$$Q_T = CI_TA$$

where:

Q_T = peak runoff rate in cubic feet per second for design storm with a return interval T-years.

I_T = rainfall intensity [in/hr] for a period of T-years and duration equal to the time of concentration for the drainage area.

A = drainage area in acres.

2.3.2 Runoff Coefficient

Utilizing a proper runoff coefficient "C" is crucial to generate accurate storm water runoff data. The runoff coefficient is influenced by factors including topography, soil type, land use, storage, size and shape of the area, imperviousness of the surface, and the degree of surface and soil saturation. Runoff coefficients presented below in Table 2 are based on the Caltrans Highway Design Manual (Caltrans, 2020). These "C" values listed were used in all hydrologic computations for this project.

Table 2 Runoff Coefficients "C" (Caltrans, 2020)

Coastal Land Use Zoning		"C"
RS-5	Residential Single Family (5000 sq. feet min.)	0.30
RS-20	Residential Single Family (20,000 sq. feet min.)	0.25
RA-2.5	Rural Residential Agriculture (2.5 ac. min)	0.15
PF	Public Facility	0.40
PR	Public Recreation (open space, coastal access)	0.10
RR	Railroad Yards	0.30
U	Unimproved	0.30
CG	Commercial General	0.50
MG	Industrial General	0.70
NR	Natural Resources	
	B – Dune and Beach Areas	0.05
	W – Wetlands	0.95

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2.3.3 Rainfall Intensity and Duration

The NOAA Precipitation Frequency Data Server was utilized to find the 1-year 1 hour intensity and the 24-hr 1, 10, and 25-year intensities. These intensities are within a 90% confidence interval (NOAA, 2017) and are presented below in Table 3. The intensities presented below were utilized in hydrologic computations.

Table 3 NOAA Precipitation Frequency Estimates for Manila, CA (NOAA, 2017)

Duration	Average Recurrence Interval		
	1-yr [in/hr]	10-yr [in/hr]	25-yr [in/hr]
1-hr	0.424	*	*
24-hr	0.103	0.175	0.208

* These intensity estimates were not utilized in any hydrologic calculations for the project.

2.3.4 Time of Concentration

Time of concentration (T_t) is the time it takes for storm water runoff to travel from the farthest point in the drainage area to a defined point of outlet. To find time of concentration, parameters such as runoff coefficient, sheet flow travel time, shallow concentrated flow time, roughness coefficient, shallow concentrated velocity, and Manning's "n" values must be considered. These parameters were used in all hydrologic calculations for the project and are in accordance with the guidelines set by the 2020 Caltrans Highway Design Manual (Caltrans, 2020).

Time of Concentration:

Sheet Flow Travel Time

$$T_t = \frac{0.42L^{4/5}n^{4/5}}{P_i^{1/2}S^{2/5}}$$

T_t = total travel time (sheet flow)

L = Length of flow path in feet

P_i = i-year, 24-hr rainfall depth in feet

S = watershed slope (average)

n = sheet flow roughness coefficient

Shallow Concentrated /Ditch Travel Time

$$T_t = \frac{L}{60V}$$

T_t = total travel time (shallow conc. flow)

L = Length of flow path in feet

V = shallow conc. velocity in feet/second

Runoff Coefficient	C = 0.50 (pervious)	Caltrans F819.2A
	C = 0.95 (impervious)	Caltrans T819.2B
Sheet Flow Roughness Coefficient	C = 0.40	Caltrans T819.2B
Shallow Concentrated Velocity	1.0 ft/s for S_{ave} = 15%	Caltrans F816.6
Manning's "n" values		

RCP	0.013	Caltrans T851.2
HDPE	0.012	Caltrans T851.2
Sand	0.020	Caltrans T866.3A
Gravel	0.030	Caltrans T866.3A
Grass Swale	0.024	Caltrans T866.3A
Vegetated Swale	0.030	Caltrans T866.3A
Asphalt	0.011	Caltrans T866.3A
Concrete	0.013	Caltrans T866.3A

2.4 Hydraulic Design

2.4.1 Bioswale Design

The SDMP recommends the use of open channels to carry storm water runoff opposed to closed conduits due to a few design criteria. Open channel construction costs tend to be considerably lower than closed conduit construction costs. Another major factor the SDMP highlights is that open channels maintain a lower average water velocity than closed conduits; this increases the time of concentration therefore also decreases the required design flow downstream. Too high channel water velocities, generally over 3 feet per second, in sandy soil can cause erosion problems. It is often difficult to design around this problem as it generally requires a relatively wide shallow cross section to obtain non-erodible velocities. Seeding the banks will help reduce erosion and required maintenance. Additionally, open channels allow overland flow to enter from most locations along their reach – making this the more versatile design choice (OLA, 1987).

Debris blockages, sediment aggradation, and woody vegetation within existing bioswale flow paths will be removed along with minor grading to restore historical or stable geometry. New bioswales will be graded to connect existing drainage paths. Banks of existing and new bioswales will be seeded and planted with native species. The drainage channels will be graded to a bottom width and side slope to convey a minimum 10-year design storm and available site constraints while also considering the recommendations from the SDMP.

Maintenance will include regular clearing of debris from culvert inlets, occasional removal of sediment, and annual maintenance of vegetation. The District will follow County, NCRA and Caltrans processes for maintenance requests as well as develop a method for completing maintenance if these entities are unable to complete maintenance in a timely manner.

2.4.2 Conduit Design

Dependent on site constraints, it may not be feasible to use open channels. Conduits will not use corrugated metal pipe (CMP) but instead use either reinforced concrete pipe (RCP) or high-density polyethylene pipe (HDPE). CMP pipes will not be used due to their short life-span and relatively high manning’s “n” value of 0.024 (Caltrans, 2020). RCP and HDPE pipes have a significantly longer life span and lower “n” value of 0.013 and 0.012, respectively. This equates to an approximately 60% increase in water capacity (OLA, 1987) assuming all other factors are constant.

Both RCP and HDPE pipes will be utilized depending on the amount of cover, estimated loading, and location. According to the National Precast Concrete Association (NPCA), RCP pipe’s main benefit is longer service life and strong durability. For locations under highly trafficked roads, using RCP tends to be the safer option because its required strength is mostly within the material, as with HDPE the strength is more reliant on proper placement and compaction (NPCA, 2009). However, RCP pipe tends to cost more for construction and delivery than HDPE. Most of the price differences come from the significant weight difference between the pipes.

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Additionally, HDPE has pre-mounted gaskets as with RCP the required joint seals are typically sold separately (NPCA, 2009). When viable, HDPE will be the preferred design choice due to its low cost, otherwise RCP will be utilized. Where existing culverts have flap gates, flap gates will be replaced along with the culvert. Existing flap gates prevent higher tides from propagating into the existing storm conveyance system.

Maintenance of RCP and HDPE pipes will include occasional cleanout of sediment and other debris. The District will follow County, NCRA and Caltrans processes for maintenance requests as well as develop a method for completing maintenance if these entities are unable to complete maintenance in a timely manner.

2.4.3 Rain Gardens

Rain gardens are landscaped depressions that function to treat on-site stormwater discharge from impermeable surfaces such as roofs, sidewalks, roadways, and parking lots (EPA, 2021). In larger areas with excessive sediment loadings, bioretention rain gardens can clog over time, therefore they are best suited for small sites in urban areas. Placement of a rain garden at the Manila Community Center can reduce overall runoff and flooding making it a safer and more functional environment.

Rain gardens are beneficial in reducing overall runoff, filtering out pollutants from stormwater runoff, and providing aesthetic value. They can be filled with native plants that also provide wildlife habitat and can increase the likelihood of plant survival (EPA, 2021).

Maintenance of rain gardens should include yearly pruning, an initial fertilization, yearly dead plant removal, and inspection of the inlet and outlet once after first rain of season then monthly during the rainy season (EPA, 2021). Overall, the maintenance requirements of rain gardens will require more labor for the first few years after construction. However, maintenance requirements tend to decrease over time (EPA, 2021).

2.4.4 Valley Gutters with Driveway Aprons

Valley gutters are a lower-cost alternative to installing new culverts in project locations that intersect residential driveways. According to the Caltrans Highway Design Manual Chapter 830, valley gutters may only be utilized in road zones of low-speeds and low frequency of traffic (Caltrans, 2020). In zones appropriate for valley gutters such as residential driveways, they are preferable over culvert installations due to relative ease of maintenance (Caltrans, 2020). Valley gutters will be designed so they are accessible for clean outs by the adjacent property owners. The installed valley gutters will be fitted with a concrete driveway apron to limit debris blockages and protect aesthetic value. The valley gutters utilized in this project will follow the standards set by the Caltrans Highway Design Manual as well as recommendations set forth by the SDMP.

3. Overview of Recommended Project

3.1 Drainage Management Area I – Young Lane Area

Drainage Management Area I (DMA I) includes the area surrounding Young Lane, portions of Hwy 255, and the northern extent of Peninsula Drive. Runoff from within DMA I is generally conveyed adjacent to the roadways from west of Hwy 255, along Young Lane and crosses under Hwy 255 and the railroad right of way before discharging to Humboldt Bay. Proposed improvements in Drainage Management Area I (DMA I) include upsizing existing culverts, a new valley gutter and debris removal and minor grading of bioswales. Project components are listed below in Table 4 and shown in Figure 3-1.

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Table 4 Project components in Drainage Management Area I

DMA ID	DMA Area (acres)	Contributing DMAs	Cumulative Contributing Drainage Area (acres)	Cumulative Contributing 10-yr 24-hr flow (cfs)	Improvement(s)
I-01	11.2	None	11.2	1.1	• N/A – as needed maintenance
I-02	2.4	None	2.4	0.2	• N/A – as needed maintenance
I-03	1.5	I-01	12.8	1.2	• Debris and aggraded sediment removal from existing bioswale along Young Ln.
I-04	3.8	I-02	6.2	0.4	• Debris and aggraded sediment removal from existing bioswale along Young Ln. • Minor grading of new bioswales along Peninsula Dr. • Replace existing 18-inch diameter culvert and headwalls at Young Ln. with 24-inch diameter culvert • Install (1) valley gutter and driveway apron at existing driveway crossing on Peninsula Dr.
I-05	1.0	I-01 to 04	20.0	1.6	• Debris and aggraded sediment removal from existing bioswale. • Replace existing 18-inch diameter culvert and headwalls at driveway crossing with 30-inch diameter culvert • Replace existing 18-inch diameter culvert and flap gate at railroad crossing with 30-inch dimeter culvert with flap gate • Debris removal with existing channel from railroad to salt marsh

3.2 Drainage Management Area II – Darin Road Area

Drainage Management Area II (DMA II) includes the area surrounding Stamps Lane, portions of Hwy 255, and Peninsula Drive, from Smigle Road to Phillips Court. Runoff from within DMA II is generally conveyed from west to east, and discharges to Humboldt Bay through multiple railroad right-of-way culvert crossings. As needed maintenance of existing drainage infrastructure is recommended in the area and is not included in this project.

3.3 Drainage Management Area III – Ward/Mill Road Area

Drainage Management Area III (DMA III) includes the area surrounding Ward Street. Runoff from within DMA III is generally conveyed from west to east, originating along the railroad right-of-way is conveyed as surface flow to Humboldt Bay without any defined stormwater conveyance system. As-needed maintenance of existing drainage infrastructure is recommended in the area and is not included in this project.

3.4 Drainage Management Area IV – Lupine Drive/Park Street Area

Drainage Management Area IV (DMA IV) includes the area west of Hwy 255, in the vicinity of Lupin Avenue and east of Hwy 255 from Peninsula Drive to Humboldt Bay, north of the Manila Community Park. Runoff from within DMA IV is generally conveyed from west to east, originating in the Lupin Avenue are to the conveyance system along and under Hwy 255 and crosses Peninsula Drive, the railroad right-of-way, and Mill Street, then along the northern boundary of Manila Community Park to Humboldt Bay. Projects within DMA IV include replacement of culverts, removal of a culvert, debris and aggraded sediment removal from existing bioswales, and grading of a new bioswale. Project components are listed below in Table 5 and shown in Figure 3-2.

Table 5 ***Project components in Drainage Management Area IV***

DMA ID	DMA Area (acres)	Contributing DMAs	Cumulative Contributing Drainage Area (acres)	Cumulative Contributing 10-yr 24-hr flow (cfs)	Improvement(s)
IV-01	55.5	None	55.5	2.2	• N/A – as needed maintenance
IV-02	1.5	None	1.5	0.1	• Installation of (3) valley gutters with new driveway aprons at residential driveways • Debris, vegetation and aggraded sediment removal from existing bioswale
IV-03	1.7	IV-01 and 02	58.7	2.5	• N/A – as needed maintenance
IV-04	0.5	IV-01 to 03	59.2	2.6	• Replace existing 18-inch diameter culvert and headwalls with 30-inch diameter culvert and headwalls at Peninsula Drive • Provide maintenance to existing bioretention swales through vegetated area between residences
IV-05	1.6	-	1.6	0.1	• Remove 30-inch culvert in vegetated area near residential properties and grade new bioswale (IV-06). • Debris, vegetation, and aggraded sediment removal from existing bioswale
IV-06	0.3	IV-01 to 05	61.2	2.7	• Excavation of new bioswale between existing bioswales • Debris, vegetation, and aggraded sediment removal from existing bioswale
IV-07	4.9	IV-01 to 06	66.1	2.9	• Debris, vegetation, and aggraded sediment removal from existing bioswale • Replace existing 18-inch diameter culverts at Mill Street and crossing near Peerless Avenue with 36-inch diameter culverts
IV-08	1.2	None	1.2	0.1	• N/A – as needed maintenance

3.5 Drainage Management Area V – Manila Park Area

Drainage Management Area V (DMA V) encompasses the Manila Community Park and a portion of Manila Avenue. Runoff generally flows east to west without any defined stormwater conveyance features. There are no improvements recommended for DMA V.

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3.6 Drainage Management Area VI – North Victor Boulevard Area

Drainage Management Area VI (DMA VI) encompasses the northern area of Victor Boulevard between Manila Avenue and Berry Lane and the railroad right-of-way to Humboldt Bay. Runoff generally flows from west to east through a culvert crossing on Victor Boulevard to Humboldt Bay. Project components within DMA VI include a culvert replacement, new culvert, and debris removal and minor grading of bioswales. A summary of the proposed improvements for Drainage VI are listed below in Table 6 and shown in Figure 3-2.

Table 6 Project components in Drainage Management Area VI

DMA ID	DMA Area (acres)	Contributing DMAs	Cumulative Contributing Drainage Area (acres)	Cumulative Contributing 10-yr 24-hr flow (cfs)	Improvement(s)
VI-01	5.2	None	1.9	0.1	• Excavation of a new bioswale between residential properties. • New 18-inch diameter culvert to convey a portion of the drainage through the existing rail prism.
VI-02	1.9	None	3.3	0.2	• Replace existing 18-inch diameter culvert crossing at Victor Boulevard with 24-inch diameter culvert. • In-Line Water Quality Unit to capture fine sediment

3.7 Drainage Management Area VII – Peninsula/Victor/Raineri/Dean Area

Drainage Management Area VII (DMA VII) encompasses the area between Peninsula Drive and Hwy 255, south of Mill Street, the southern area of Victor Boulevard and the area west of Hwy 255 in the vicinity of Pacific Avenue. Runoff generally flows from north to south discharging to Humboldt Bay adjacent to the railroad right-of-way south of Manila. Projects components within DMA VII include replacement of existing culverts, addition of a stormdrain pipe, and debris and vegetation removal and minor grading of existing bioswales. A summary of the project components for DMA VII are detailed below in Table 7 and shown in Figure 3-2 and Figure 3-3.

Table 7 Project components in Drainage Management Area VII

DMA ID	DMA Area (acres)	Contributing DMAs	Cumulative Contributing Drainage Area (acres)	Cumulative Contributing 10-yr 24-hr flow (cfs)	Improvement(s)
VII-01	1.7	None	1.72	0.10	• New 18-inch diameter stormdrain pipe in Peninsula Drive • Excavation of bioswales along the Peninsula Drive
VII-02	0.4	VII-01	2.08	0.12	• N/A – as needed maintenance
VII-03	4.0	VII-01 to 02	6.1	0.4	• Replace existing 12-inch diameter culvert crossing at Peninsula Drive with 18-inch diameter culvert.

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DMA ID	DMA Area (acres)	Contributing DMAs	Cumulative Contributing Drainage Area (acres)	Cumulative Contributing 10-yr 24-hr flow (cfs)	Improvement(s)
VII-04	4.4	None	4.4	0.5	• Replace existing 18-inch culvert with 24-inch culvert from railroad bioswale to Hwy 255 bioswale • Replace existing 18-inch diameter culvert at railroad crossing with 24-inch dimeter culvert • Debris, vegetation, and aggraded sediment removal from existing bioswale
VII-05	2.2	None	2.2	0.1	• N/A – as needed maintenance
VII-06	7.6	VII-01 to 05 and 11	30.9	2.1	• Replace existing 24-inch diameter culvert and flap gate at railroad crossing with 36-inch dimeter culvert with flap gate
VII-07	2.5	None	2.5	0.2	• Installation of valley gutter or culvert at driveway crossing • New 18-inch diameter culvert crossing at Peninsula Drive • New bioswale along western edge of Peninsula Drive • Remove aggraded sediment from historical bioswale along eastern edge of Peninsula Drive
VII-08	0.8	VII-07	3.3	0.3	• Remove aggraded sediment from historical bioswale along eastern edge of Peninsula Drive
VII-09	3.2	VII-07 to 08	6.6	0.6	• Replace existing 12-inch diameter culvert on Lupin Avenue with 18-inch dimeter culvert • Debris, vegetation, and aggraded sediment removal from existing bioswale
VII-10	1.2	VII-07 to 09	7.7	0.7	• Debris, vegetation, and aggraded sediment removal from existing bioswale • Replace existing 12-inch diameter culverts (2) at private drive railroad crossings with 18-inch dimeter culverts and headwalls • New 18-inch dimeter culvert and headwalls at future private drive railroad crossing
VII-11	10.7	None	10.7	1.0	• Replace existing 12-inch diameter culvert at private drive railroad crossings with 18-inch dimeter culverts and headwalls • Debris, vegetation, and aggraded sediment removal from existing bioswale • New 18-inch dimeter culvert and headwalls at future private drive railroad crossing

3.8 Drainage Management Area VIII – Peninsula Drive Area

Drainage Management Area VIII (DMA VIII) is located at the southernmost end of Manila and is bordered by DMA VII to the north, dune, and wetlands to the south and west, and Humboldt Bay to the east. Runoff is generally from west to east, accumulating in localized depressions without formalized stormdrain conveyance systems, with the exception of drain inlets and stormdrain pipes at the Manila Community Center. Project components within DMA VIII include the replacement of the existing stormdrain system at the Community Center with an interactive rain garden and installation of a series of bioswales and rain gardens along the edge of Peninsula Drive. A summary of the proposed drainage improvements for Drainage Area VIII described below in Table 8 and shown in Figure 3-3.

Table 8 Recommended Improvements for Drainage Management Area VIII

DMA ID	DMA Area (acres)	Contributing DMAs	Cumulative Contributing Drainage Area (acres)	Cumulative Contributing 10-yr 24-hr flow (cfs)	Improvement(s)
VIII-01	0.3	None	0.3	0.02	• Remove existing drain inlets and pipes at Manila Community Center and replace with interactive rain garden • Replace existing 6-inch diameter stormdrain pipe with 12-inch diameter stormdrain pipe.
VIII-02	6.5	None	6.5	0.3	• Install series of rain gardens, bioswales and valley gutters along Peninsula Dr.

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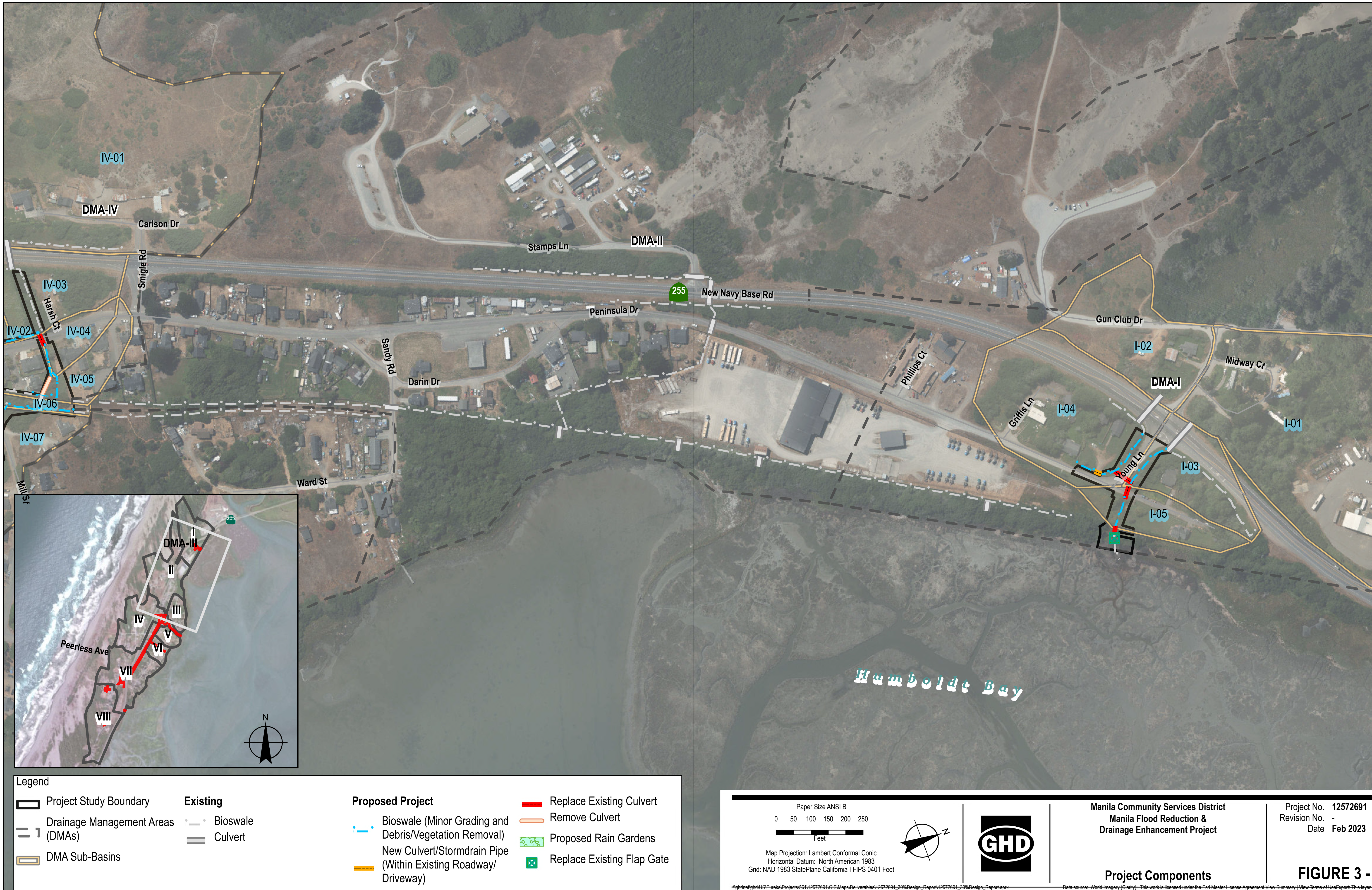

Paper Size ANSI B

0 50 100 150 200 250

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

GHD

Manila Community Services District
Manila Flood Reduction & Drainage Enhancement Project

Project Components

Project No. **12572691**
Revision No. **-**
Date **Feb 2023**

FIGURE 3 - 1

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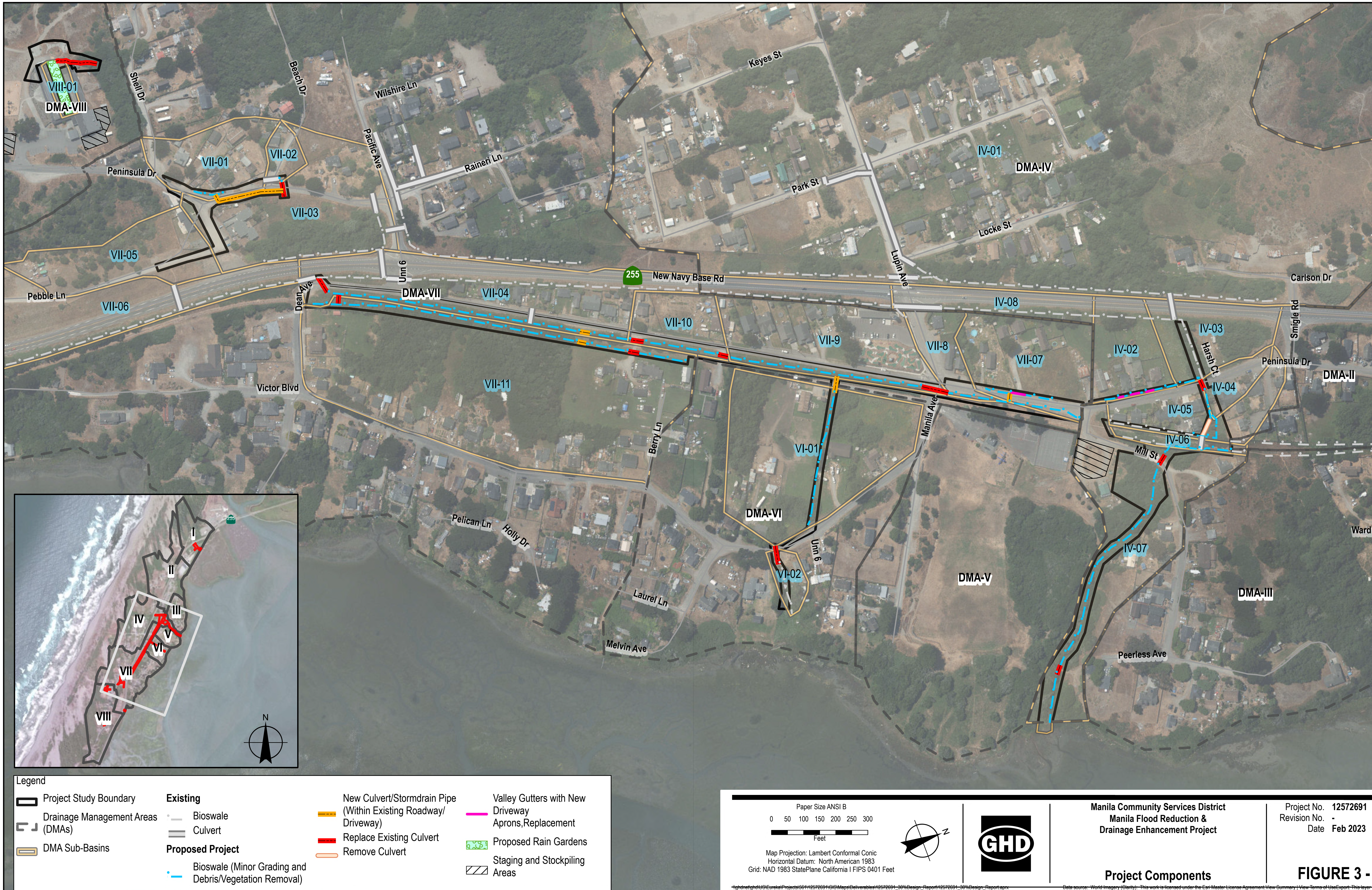
Print date: 15 Feb 2023 - 15:39

Data source: World Imagery (Clarity): This work is licensed under the Esri Master License Agreement.View Summary | View Terms of UseExport: This layer is not intended to be used to export tiles for offline. Data Collection and Editing: This layer may be used in various ArcGIS apps to support data collection and editing, with the results used internally or shared with others, as described for these use cases.
AirPhoto_2019_: . Created by: jlopez4



Manila Community Services District
Manila Flood Reduction &
Drainage Enhancement Project

Project No. 12572691
Revision No. -
Date Feb 2023

Project Components

FIGURE 3 - 2

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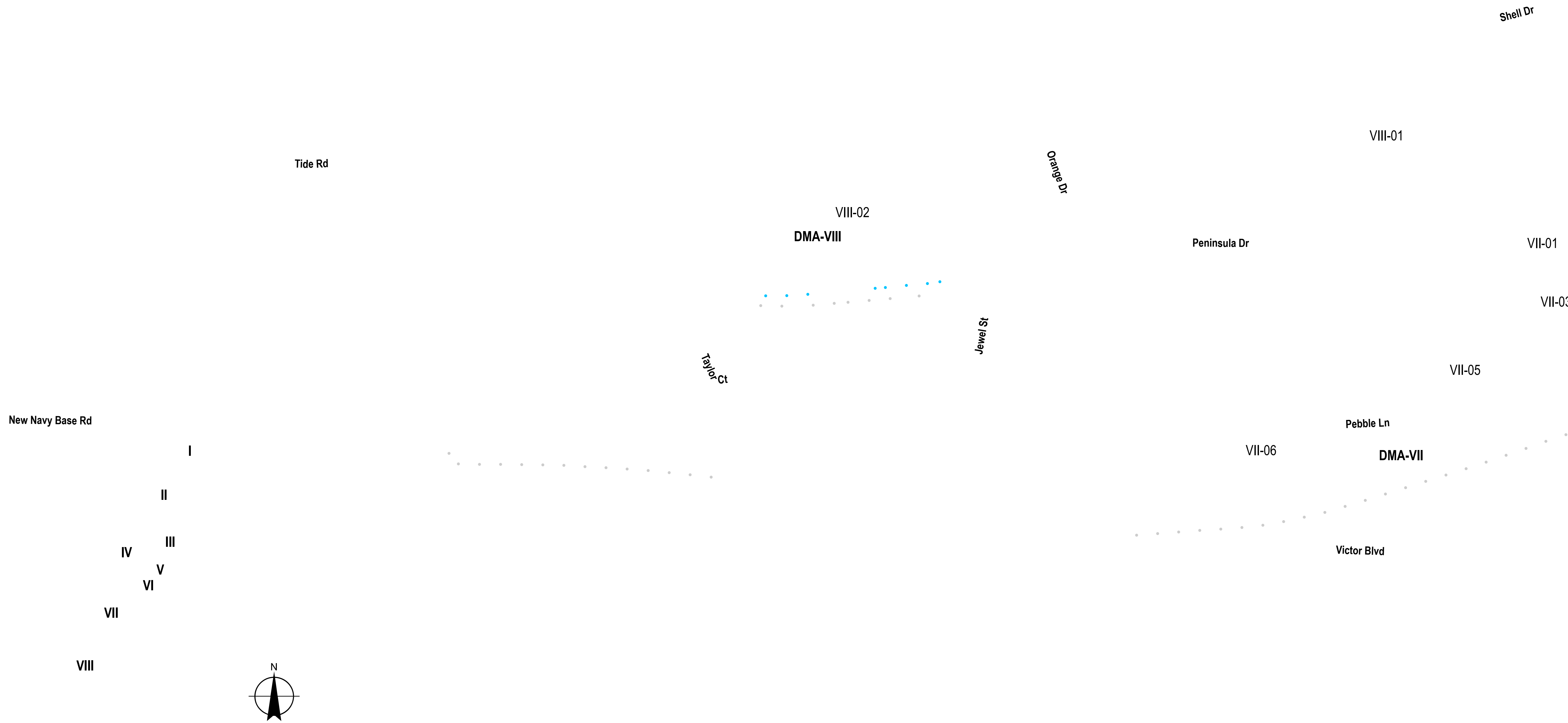

Legend

Project Study Boundary

Drainage Management Areas (DMAs)

DMA Sub-Basins

Existing

Bioswale

Culvert

Proposed Project

Bioswale (Minor Grading and Debris/Vegetation Removal)

Replace Existing Culvert

Valley Gutters with New Driveway Aprons,Replacement

Proposed Rain Gardens

Staging and Stockpiling Areas

Paper Size ANSI B

0 50 100 150 200 250

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Manila Community Services District
Manila Flood Reduction &
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Project No. **12572691**
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Project Components

FIGURE 3 - 3

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