Drainage Master Plan Update

ADOPTED October 19, 2022

City of Ferndale

Prepared by:

Ontiveros & Associates Inc
Consulting Engineers and Surveyors

PlanWest Partners, Inc.

RESOLUTION No. 2022-23

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF FERNDALE MAKING FINDINGS PURSUANT TO THE CALIFORNIA ENVIRONMENTAL QUALITY ACT AND ADOPTING THE 2022 DRAINAGE MASTER PLAN UPDATE

WHEREAS, the City of Ferndale maintains a city-wide stormwater drainage system;

WHEREAS, storm runoff associated with heavy winter rains cause chronic flooding and sedimentation problems in the relatively flat terrain in the City highlight the need for a Drainage Master Plan to identify deficiencies in the existing drainage system, recommend projects to reduce flood damage, support the Drainage Fee ordinance, i.e., Ordinance No. 94-01, and provide guidance for the development of future drainage facilities;

WHEREAS, the City of Ferndale's adopted 2019-2027 Housing Element identifies localized flooding as a constraint on housing development in the City;

WHEREAS, the City adopted a Drainage Master Plan in 1994 and a Drainage Master Plan Update in 2004;

WHEREAS, the City Engineer prepared the 2022 Drainage Master Plan Update including identification of improvements with an estimated construction cost of $1.4 million;

WHEREAS, the 2022 Drainage Master Plan Update is not a mandate of required improvements, but a planning tool to be used by the City in developing future capital improvement program budgets;

WHEREAS, the development and adoption of a 2022 Drainage Master Plan Update is statutorily and categorically exempt from analysis under the California Environmental Quality Act (CEQA) pursuant to Sections 15262 and 15306, respectively, of the CEQA Guidelines;

WHEREAS, the Drainage Committee reviewed and commented on the 2022 Drainage Master Plan Update as part of their June 2, 2022, August 4, 2022, and October 6, 2022 regular meetings; and

WHEREAS, on October 6, 2022, by unanimous vote, the Drainage Committee recommended that the City Council adopt the 2022 Drainage Master Plan Update.

NOW, THEREFORE, BE IT RESOLVED, DETERMINED AND ORDERED by the City Council of the City of Ferndale in the County of Humboldt hereby resolve, declare, and order as follows:

Section 1. The foregoing recitals are true and correct, and constitute the findings of the City Council in support of this resolution.

Section 2. The City Council adopts the City of Ferndale 2022 Drainage Master Plan Update.

Section 3. Direct City staff to prepare and file a Notice of Exemption with the County Clerk and Office of Planning and Research.

IT IS HEREBY CERTIFIED that the City Council of the City of Ferndale duly introduced and regularly adopted the foregoing resolution at regular meeting held October 19, 2022, by the following vote:

AYES: 5
NOES: 0
ABSENT: 0
ABSTAIN: 0

Don Hindley

Don Hindley, Mayor

Attest:

Kristene Hall

Kristene Hall, City Clerk

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Executive Summary

The Ferndale Drainage Master Plan Update is a long-range planning tool that identifies deficiencies in the existing drainage system, provides a recommended course of action to reduce flood damage, supports the drainage fee ordinance, establishes a fee schedule for development, and provides guidance for the development of future drainage facilities. The 2022 update builds on information provided in the 2004 update and utilizes the most current methodology available in order to assess flow patterns throughout the City.

Utilizing the updated hydrologic model for the City, drainage problem areas were identified and a list of recommended improvement projects was developed through consultation with the Ferndale Drainage Committee and site visits. The recommended improvement projects and their estimated costs are listed below. The projects are listed in order of their priority.

Existing Problem Areas and Recommended Solutions

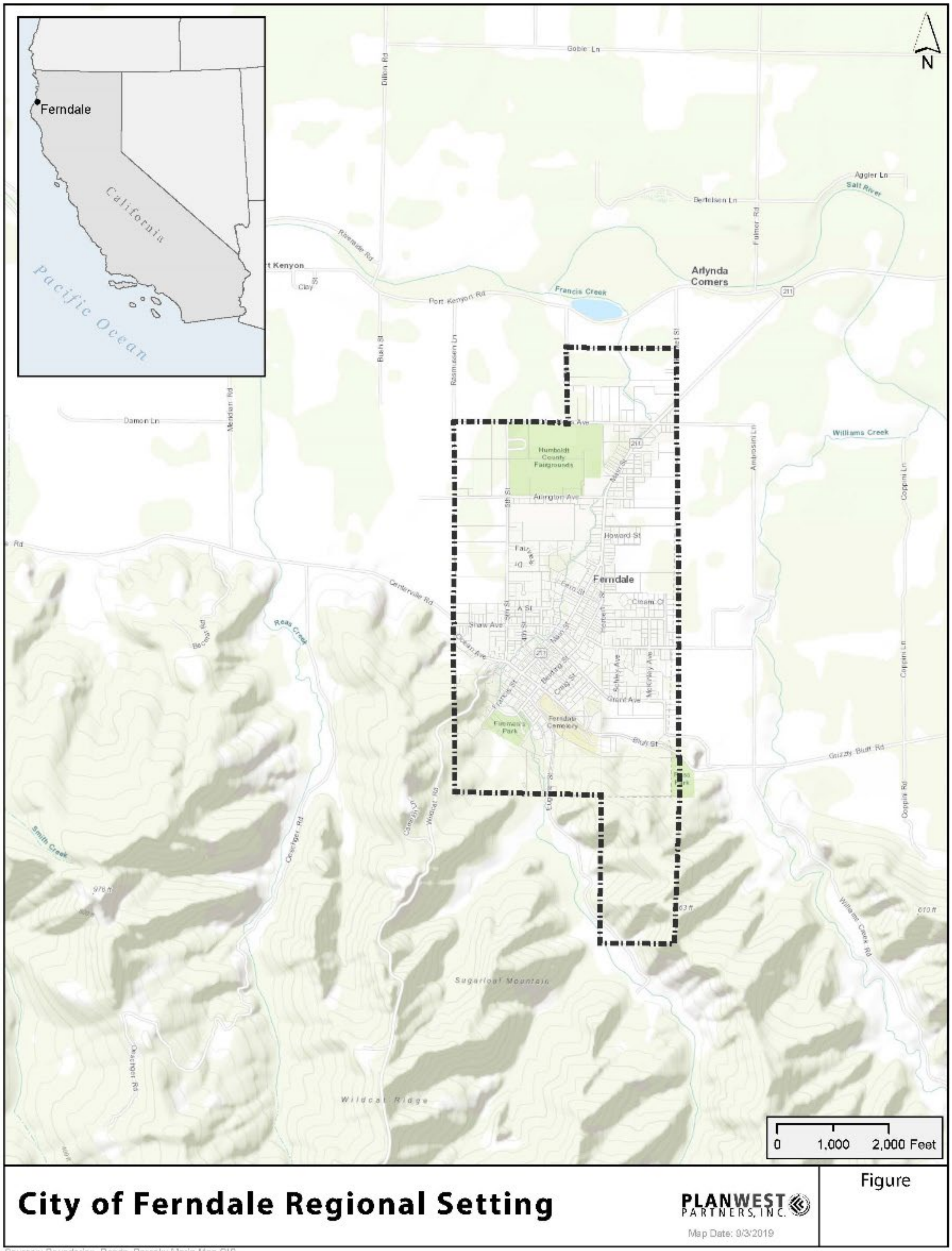
		Est. Cost
1	At Berding & Herbert Streets Replace (E) ±15"CMP pipe with 50' of New 24-inch HDPE pipe	$21,000
2	At Berding St. & Shaw Ave. Install ±305' of 12-inch HDPE and drainage inlets.	$83,580
3	At Dewey Ave. Install ±460' of 24-inch HDPE pipe and drainage Inlets from Herbert St. to the East Side Drainage Channel	$204,300
4	At Rose Ave. Replace (E) 12" CMP with ±505' of 18-inch HDPE pipe. Will require obtaining easements and working in narrow areas. Estimated cost does not include the cost to acquire easements.	$193,980
5	At 5th St. & Milky Way, Install ±550' of HDPE pipe from Milky Way to Drainage Channel with drainage inlets	$236,340
6	At Ambrosini Lane, Install ±325' of 36-inch HDPE pipe. Will require obtaining easements.	$109,200
7	At Arlington Ave at 5th St. Install ±1800' of 18-inch & 24-inch HDPE pipe from Arlington Ave. to Van Ness Ave.	$575,460
	TOTAL	$1,423,860
	Note: Estimated costs include design, bidding, and construction management in 2022 dollars	

It is the recommendation of this report that these projects be implemented as drainage funds become available. Assuming a 20-year planning period, the City will have to spend $71,193 per year in 2022 dollars to complete all of the capital improvement projects.

The estimated cost to perform annual maintenance on Ferndale's existing drainage facilities is $20,000 including labor. Therefore, the estimated total annual drainage expense for capital improvement projects and annual maintenance will be $91,193.

There are currently two sources of funds for drainage improvements and maintenance: 1) Development Drainage Fees; and 2) an Annual Drainage Assessment. In 1997, the voters approved the establishment of a Drainage Assessment District within the City Limits with the authority to assess each parcel a $25 annual drainage fee. The Lytel Foundation, a local non-profit organization, contributed $25,000 per year to the City in-lieu of the City implementing the property drainage assessment for several years. However, this assessment is now paid by property owners.

Based on the current fee and assessment structure, the projected revenue for drainage improvement projects is significantly less than the projected expenses. As such, it is unlikely that the seven drainage improvement projects on the priority list will be completed within the 20 year planning period unless either the current fee and assessment structure is adjusted, other outside (state, federal) funds are obtained, a loan is taken, or bonds are sold.



Sources: Boundaries, Roads, Parcels: Marin Map GIS.

Figure 1: City of Ferndale Regional Map

Chapter 1 - INTRODUCTION

The City of Ferndale is a small, historic dairy community located within the Eel River Valley, roughly 15 miles south of Eureka in Humboldt County. The City and surrounding area are within the Salt River watershed, which in turn flows into the Eel River near its mouth.

The City is built on the historic alluvial fan of Francis Creek and local flooding occurs when Francis Creek is breached. As Francis Creek is the high point within the city, flood waters fun downhill and have historically flooded Main Street, Shaw Avenue, Rose Avenue, and other local roads covering many areas with a deep layer of silt.

Ferndale and the surrounding areas have historically had problems with storm water and drainage due to the relatively flat topography of the region and its location within the Eel River floodplain. Storm runoff associated with heavy winter rains has caused chronic flooding and sedimentation problems in the relatively flat terrain in the City, and in the rural areas north of the City near the Salt River. The City of Ferndale has recognized that continued growth can only take place in or adjacent to those portions of the city experiencing chronic flooding, and that management of storm water runoff is in the public interest.

1.1 - Geology and Hydrology

The Eel River is the third largest river system in California, with a 3,680-square-mile watershed that includes portions of Trinity, Mendocino, Humboldt, Glenn, and Lake Counties. The watershed's dominant geologic formation is the Franciscan Complex, which is prone to landslides and is highly erodible, particularly on steep slopes. However, the lower Eel River areas is comprised of over 50% Cenozoic Sedimentary rocks[i]. The area is underlain by alluvial deposits consisting of fine-grained fluvial and flood deposits composed of interbedded silts, clays, and fine sands derived from nearby watercourses (Salt River, Francis Creek, and Eel River). These deposits are young and as such are generally poorly consolidated and susceptible to liquefaction during strong ground shaking.

The geology of the City is primarily classified as Q – Marine and Nonmarine (continental) Sedimentary rocks which is described as alluvium, lake, playa, and terrace deposits. A small portion of the City in the hill areas to the south is classified as Qoa – Marine and Nonmarine (continental) Sedimentary rocks which is described as older alluvium, lake, playa, and terrace deposits[ii]. Soils in the area are primarily Weott (0 to 2 percent slopes) with some Loleta (2 to 5 percent slopes), Fiedler-Petellen-Nanningcreek complex (30 to 50 percent slopes), and Swainslough (0 to 2 percent slopes)[iii]. Various other soils exist in the area in minimal amounts.

The City sees a normal annual precipitation of 40.33 inches[iv] and benefits from the marine cloud layer that covers the area on an almost daily basis. Major hydrological features in and around the City include the Eel River approximately 3 miles north and 5.5 miles east of the City center, and the Pacific Ocean approximately 4 miles to the west. Francis Creek, which runs south to north through the City center, is a tributary to the Salt River, which then discharges into the Eel River slough at the river mouth. Francis Creek is a perennial stream with a small watershed, where stream flows quickly subside after moderate rain events. Williams Creek is located just east of the City and also flows into the Salt River. Flooding events occur periodically in the area during large storms with the last event occurring in Spring 2019.

Much of the City is flat in nature with a less than 5% grade. The City maintains a stormwater system separated into east and west drainage basins by Francis Creek. Stormwater from the City eventually flows into the Salt River to the north[v]. Surface water flows generally follow natural contours and waterways but have also been altered by constructed features (e.g. drainage channels, detention basins) including the City's stormwater system.

Francis Creek

The Francis Creek Watershed has a drainage area of approximately 1,990 acres. Francis Creek is normally a small, babbling brook which runs year-round, winding through the very heart of the City. The Creek's flood carrying capacity is restricted by culverts, bridges, sediment build-up, and debris. Flooding from Francis Creek has been historically documented at regular intervals, and varying intensities. Annual

Figure 2: Francis Creek at Main St and Shaw Ave

removal of any vegetation that could cause debris dams in the Francis Creek channel has so far been successful in reducing flooding potential.

Through the Governor's Office of Emergency Services (OES), the City of Ferndale applied for a FEMA Flood Hazard Mitigation Grant in January 1996 to primarily increase the flow capacity of Francis Creek. Approval of funding to proceed with a Phase 1 study and report was received on October 31, 1997. The Phase 1 Report was completed in March 1998.

The City received notification of funding approval for the project from OES in November 1999. In order to work effectively in Francis Creek during the relatively short construction season, the project was divided into three phases. Beginning in June, 2000 work began on the first phase of construction at the most downstream point. The City partnered with Caltrans to receive $764,000 towards completion of the first phase of work, at the most downstream portion of the project, part of which was within the Caltrans Highway 211 right-of-way. The first phase of work was substantially complete in December 2000.

Construction began on Phase 2 of the project in June 2001. The work included widening much of the middle section of the creek and replacing two bridges. The City was successful in obtaining a California Department of Water Resources Urban Streams Restoration Grant of $270,000 to help fund a portion of the Phase 2 work. Phase 2 construction work was completed in November 2001.

The final phase of construction included the replacement of the two most upstream bridges of the project, and the installation of the east side drainage improvements. The work began in June 2002 and was substantially complete in September of the same year.

The design team employed several methods to complete the channel widening. In general, the lower portions for the creek bank were armored with large rock slope protection with interwoven plantings of native thimbleberry, ferns, and wild strawberries. Some of the upper sections of bank were lined with a biodegradable mesh fabric, with similar plantings. Larger bushes and trees were planted along the top of the bank to provide a future shade canopy. Habitat enhancing rock clusters were also placed at strategic locations in the creek channel. All of the new bridges included at least three feet of rock fill over foundation footings. This was intended to provide a channel bed of natural material.

The City was fortunate that the winters of 2000 and 2001 were relatively mild, with below normal rainfall. The new landscaping generally had time to develop and take hold on the creek banks that had been widened during the first two phases of work. The entire project was completed just before the extreme storm events of December 2002. Francis Creek was able to handle the storm flows with only minor overtopping at Fern Avenue and Shaw Avenue.

In January 2017, heavy rains flooded much of the lower Eel River estuary (Figure 2). During this time, the Eel River exceeded its flood stage off 20 feet from January 9 to 11[vi]. During this same period, the Salt River flooded in many areas along Port Kenyon Road (Figure 3).

Similar flooding occurred again in early 2019. These large flood events often result in the closure of Highway 211 at Fernbridge as flood waters typically flow over the roadway (Figure 4).

Photo Source: Caleb Lesher via Lost Coast Outpost

Figure 4: Lower Eel River Estuary January 9, 2017

Photo Source: Dobson Images

Figure 3: Salt River near Port Kenyon Rd at Meridian Rd

Photo Source: Lost Coast Outpost

Figure 5: Flood Waters Over Highway 211 - February 2019

1.2 - City Stormwater Subareas

The City of Ferndale's stormwater drainage systems can be split into two subareas east and west of Francis Creek. In an effort to reduce the amount of runoff entering Francis Creek and help alleviate flooding though the City center, drainage infrastructure routes stormwater away from Francis Creek to areas that are more capable of receiving higher flows.

East Side Subarea

The East Side drainage system consists of a network of street gutters, storm sewers, culverts, and drainage channels that convey runoff to a natural low profile drainage swale referred to as the East Side Channel. The East Side Channel lies about 2,000 feet east of Francis Creek and flows north to Market Street and Van Ness Street where it converges with a County maintained ditch. On the eastern edge of the City near Arlington and Milton Avenues is a large depression along the East Side Channel. This depression collects water runoff and provides for infiltration and slower runoff into the rest of the system which helps prevent flooding downstream.

In addition to draining the easterly portion of the City, the East Side Drainage Channel collects overflows (floodwaters) from both Francis Creek to the west and Williams Creek to the east. The flood mitigation projects completed on Francis Creek in the early 2000's increased the capacity of the channel to allow it to contain a 25-year design storm. This significantly reduced the frequency of Francis Creek overflows which has alleviated some of the previous flooding problems experienced in East Side Subarea.

West Side Subarea

The West Side drainage system consists of a network of street gutters, drainage channels, and culverts. The west side drainage area is absent of any storm sewers except for the Ferndale Housing area and a small internal drainage system at the County Fairgrounds. The remaining acreage contains a series of drainage channels all running northerly to Port Kenyon Road where runoff ponds, percolates, or drains west in a small agricultural ditch.

The drainage channels are draining near maximum capacity and any increase in storm water will only contribute to additional unmanaged run-off. Furthermore, these drainage ditches can become densely vegetated, especially during the spring months. This vegetation significantly decreases the hydraulic efficiency of the channels and their capacity to convey stormwater runoff.

1.3 - Plan History

The City Council formed an ad-hoc Drainage Committee in 1989 to consider matters related to storm drainage within the City. In 1990 the City adopted a Drainage Master Plan which recognized the need to complete many major drainage improvements within the City limits. The Drainage Master Plan also recognized the limits imposed by both the Salt River and the Eel River estuary, in that these areas greatly influence drainage within the City. In 2020, the City formed a permanent Drainage Committee to address on-going drainage issue within the Francis Creek and adjoining watersheds affecting the City storm drainage system.

In 2003 and 2004 the City conducted a comprehensive update to the Drainage Master Plan. The 2004 update included a summary of drainage improvements since 1990, conducted a hydrological analysis of the City's infrastructure based on the best available data, and identified a series of projects that would help further alleviate drainage issues in and around the City. Many of these projects were not completed due to lack of funding. Some of the projects have been carried over to the current update.

1.4 - Current Update

Since 2004, mapping and modeling technology has advanced significantly. Current Lidar data is available for the City that provides a detailed topographic representation of features at a nominal pulse spacing of 0.35 meters (1.15 feet)[vii]. The current update to the Drainage Master Plan will take into consideration the new data available along with new data gathered through a series of field surveys to provide a detailed hydrologic model of the City. Additionally, this update will:

- Identify improvement projects that have occurred since 2004
- Update and develop relevant maps
- Identify existing and potential future drainage issues
- Establish an updated project list with recommended priorities and estimated project costs
- Review funding methods and develop a new drainage fee rate structure

Chapter 2 - Methodology

2.1 - Methodology Summary

This 2022 Storm Drainage Master Plan began with an identification of the land area contributing water to the Ferndale storm drainage system. The study area was defined as all areas within the Ferndale city limits and any area that contributes storm water to the city limits. Most pipes, channels, manholes, drainage inlets, and drainage swales within the city limits are included in the analysis. The city limits were walked to confirm the drainage infrastructure defined in the 2004 Drainage Master Plan. Drainage inlet grates were removed, where feasible, and physical data was recorded. A survey crew, under the direction of a licensed land surveyor, measured the grate and invert elevations of the identified drainage inlets. Other physical data was also noted, including the pipe diameter, the pipe material, the grate type and grate slope, as well as any additional information that may affect the capture efficiency of the inlet or pipe. There were multiple locations where not all of the physical data could be measured. In these locations the “most likely” scenario was identified and used for the analysis. Due to the project budget, not all pipes and channels were able to be surveyed. In these cases, the best information available was used to develop the drainage model.

The contours used to determine flow direction and individual drainage boundaries are shown at 1 foot contours and are based on the 2018-2019 Northern California Wildlife USGS Lidar Data Set. These lidar maps for the City of Ferndale were used to create drainage (catch) basins associated with each drainage inlet. Using the defined zoning parameters for the City of Ferndale, the terrain of each drainage basin, and the water drainage path (determined from the lidar map), the time of concentration for each drainage basin was computed.

The physical data obtained in the field was input into a hydraulic modeling software. Within the software, A user-defined IDF (Intensity-duration-frequency) curve was developed using the historic rainfall data from the city of Ferndale. For purposes of this study, the 25-year storm was used in the analysis.

Based on the time of concentration[1], total land area, the 25-year storm rainfall data, and terrain of each individual drainage basin, the total hydrology (Peak flow, total volume of water, conduit capacity, peak velocity) of the drainage system was calculated.

From this data, areas with inadequate drainage infrastructure could be further analyzed. Once the base model containing the current state of the Ferndale drainage was completed and analyzed, scenarios were developed to determine the best method for repairing the “areas of concern.” The developed scenarios allowed hypothetical situations to be analyzed (changing pipe diameters, adding pipes or drainage inlets, changing channel geometry) without affecting the base model.

2.2 - Hydrologic Modeling Method

While the 2004 Ferndale Master Plan Update used the **Rational Method**, our hydrologic modeling was performed using the **Modified Rational Method**. With advances in computational power in recent years, engineers have turned to the modified rational method for more accurate hydrology results. For a small town, the storm drain system in Ferndale is somewhat “complex.” There are over 100 small subdrainage

[1] Time of Concentration = (Tc) is the time required for runoff to travel from the hydraulically most distant point on the catch basin to the drainage inlet.

basins, each with its own individual hydrologic data. The total area analyzed in the analysis was just under 900 acres.

The greatest drawback to the rational method is that it only provides one point on the runoff hydrograph. The modified rational method uses a more real-world scenario in which the storm intensity is fluid. If a drainage basin has a time of concentration of say 120 minutes, it's unreasonable to assume that the storm intensity holds constant for 120 minutes. Also, when areas become complex and where multiple drainage basins are converging into the shared storm system, the rational method will tend to overestimate the actual flow. This results in over-sizing of drainage facilities or unnecessary construction to upgrade a pipe or channel when the project isn't necessary.

Urban Drainage and Flood Control District, Colorado USA (2007) did an analysis of the modified rational method vs the rational method and had the following to say:

> *For urban catchments that are not complex and are generally 160 acres or less in size, it is acceptable that the design storm runoff be analyzed by the rational method. Further stated, that the greatest drawback to the rational method is that it normally provides only one point on the runoff hydrograph. When the areas become complex and where sub-catchments come together, the rational method will tend to overestimate the actual flow, which results in oversizing of drainage facilities. The rational method provides no direct information needed to route hydrographs through the drainage facilities. One reason the rational method is limited to small areas is that good design practice requires the routing of hydrographs for larger catchments to achieve an economic design.*

For these reasons it was decided to model the City of Ferndale's storm drainage system using the **Modified Rational Method**.

THE MODIFIED RATIONAL METHOD

The Modified Rational Method is based on the formula:

$$Q = C i A ,$$

where

Q = Maximum rate of runoff (cfs)
C = Runoff Coefficient
i = average rainfall intensity in inches per hour from the intensity- duration – frequency relationship for a specific return period and dura
A = The contributing basin area (acres)

RUNOFF COEFFICIENT, C

The runoff coefficient was calculated for each individual catchment (drainage) basin. Each catchment area has a different value of C based on the characteristics of the area. The coefficient, C, represents the integrated effects of infiltration, evaporation, retention, flow routing, and interception, all which affect the time distribution and peak rate of runoff of the individual catchment.

The Values of 'C' were assigned to the various land use zoning classifications as defined in the Ferndale General Plan and noted on the Ferndale Zoning map. The 'C' values used have been modified from the 2004 DMPU as noted in table 1. The Design 'C' values noted in table 1 were derived from an analysis for each type of land-use designation and based on public input from the drainage committee.

When a catchment basin has more than one 'C' value (zone) within its boundaries a composite runoff coefficient must be computed. The composite coefficient is based on the percentage of different types of surface or zones in the drainage area. The composite runoff coefficient is found from the following equation:

$$C = \frac{C_1 A_1 + C_2 A_2 + \ldots\ C_n A_n}{A_1 + A_2 + \ldots\ A_n}$$

Where n is the number of sub-catchments in the watershed.

Abbreviation	Land Use Designation	Dwelling Units/Acre	2004 DMPU Run-off Coefficient, C	Design Run-off Coefficient, C
R-S	Residential Suburban	0-1	.40	.30
R-1	Residential One-Family	0-7	.55	.75
R-1-B-1	Residential One Family Building Site Combining	0-5	.50	.65
R-1-B-2	Residential One Family Building Site Combining	0-4	.45	.60
R-1-B-3	Residential One Family Building Site Combining	0-2	.40	.55
R-2	Residential Two-Family	0-14	.60	.75
R-3	Residential Multiple-Family	0-21	.70	N/A
R-4	Apartment Professional	0-21	.70	.80
C-1	Neighborhood Commercial	N/A	.85	.95
C-2	Community Commercial	N/A	.85	.95
A-E	Agriculture Exclusive	N/A	.25	.25
P-F	Public Facility	N/A	.25-.60	.25-.60
P	Pasture	N/A	.20	.20
F	Forest and Watershed	N/A	.20	.20
Cemetery	Local Cemetery	N/A	.6	.6
Road	Roadways and Driveways	N/A	.90	.95

Table 1: Zoning classifications and the Corresponding C Values (Ferndale)

Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: Ferndale, California, USA*
Latitude: 40.5833°, Longitude: -124.2638°
Elevation: 37.31 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.61** (1.42-1.85)	**1.94** (1.70-2.24)	**2.41** (2.11-2.78)	**2.82** (2.45-3.28)	**3.40** (2.83-4.10)	**3.85** (3.14-4.78)	**4.34** (3.46-5.53)	**4.87** (3.76-6.40)	**5.63** (4.14-7.74)	**6.24** (4.42-8.92)
10-min	**1.15** (1.01-1.32)	**1.40** (1.22-1.60)	**1.73** (1.52-2.00)	**2.02** (1.75-2.35)	**2.43** (2.03-2.94)	**2.76** (2.26-3.42)	**3.11** (2.47-3.97)	**3.50** (2.69-4.59)	**4.04** (2.96-5.54)	**4.48** (3.16-6.39)
15-min	**0.928** (0.816-1.06)	**1.12** (0.988-1.29)	**1.40** (1.22-1.61)	**1.63** (1.41-1.90)	**1.96** (1.64-2.37)	**2.23** (1.82-2.76)	**2.51** (2.00-3.20)	**2.82** (2.17-3.70)	**3.25** (2.39-4.47)	**3.61** (2.55-5.15)
30-min	**0.628** (0.552-0.720)	**0.760** (0.668-0.876)	**0.944** (0.826-1.09)	**1.10** (0.954-1.28)	**1.33** (1.11-1.60)	**1.51** (1.23-1.86)	**1.70** (1.35-2.16)	**1.91** (1.47-2.50)	**2.20** (1.62-3.02)	**2.44** (1.73-3.48)
60-min	**0.440** (0.387-0.505)	**0.533** (0.468-0.614)	**0.662** (0.580-0.764)	**0.772** (0.670-0.899)	**0.929** (0.776-1.12)	**1.06** (0.862-1.31)	**1.19** (0.946-1.52)	**1.34** (1.03-1.75)	**1.54** (1.13-2.12)	**1.71** (1.21-2.44)
2-hr	**0.336** (0.296-0.386)	**0.402** (0.352-0.462)	**0.491** (0.430-0.566)	**0.568** (0.492-0.661)	**0.676** (0.565-0.818)	**0.764** (0.624-0.946)	**0.858** (0.681-1.09)	**0.957** (0.736-1.26)	**1.10** (0.807-1.51)	**1.21** (0.858-1.73)
3-hr	**0.290** (0.255-0.333)	**0.345** (0.303-0.396)	**0.419** (0.367-0.484)	**0.482** (0.418-0.561)	**0.571** (0.477-0.691)	**0.643** (0.525-0.796)	**0.718** (0.570-0.914)	**0.799** (0.615-1.05)	**0.911** (0.669-1.25)	**1.00** (0.708-1.43)
6-hr	**0.222** (0.195-0.255)	**0.264** (0.231-0.303)	**0.319** (0.279-0.368)	**0.364** (0.316-0.424)	**0.428** (0.358-0.518)	**0.478** (0.390-0.592)	**0.530** (0.421-0.674)	**0.584** (0.449-0.766)	**0.658** (0.484-0.905)	**0.717** (0.507-1.02)
12-hr	**0.163** (0.143-0.187)	**0.196** (0.172-0.225)	**0.238** (0.209-0.275)	**0.273** (0.236-0.317)	**0.319** (0.266-0.385)	**0.353** (0.289-0.438)	**0.389** (0.309-0.495)	**0.424** (0.327-0.557)	**0.472** (0.347-0.649)	**0.508** (0.360-0.726)
24-hr	**0.118** (0.106-0.134)	**0.144** (0.129-0.164)	**0.177** (0.158-0.201)	**0.203** (0.180-0.232)	**0.236** (0.204-0.279)	**0.261** (0.222-0.314)	**0.286** (0.238-0.350)	**0.310** (0.252-0.389)	**0.342** (0.268-0.445)	**0.365** (0.278-0.490)
2-day	**0.078** (0.070-0.089)	**0.096** (0.086-0.109)	**0.119** (0.106-0.135)	**0.136** (0.121-0.157)	**0.159** (0.138-0.188)	**0.176** (0.149-0.211)	**0.192** (0.160-0.235)	**0.208** (0.169-0.261)	**0.228** (0.179-0.297)	**0.243** (0.185-0.326)
3-day	**0.062** (0.055-0.070)	**0.077** (0.069-0.087)	**0.095** (0.085-0.108)	**0.109** (0.097-0.125)	**0.127** (0.110-0.150)	**0.141** (0.120-0.169)	**0.154** (0.128-0.189)	**0.166** (0.135-0.209)	**0.183** (0.143-0.238)	**0.195** (0.148-0.261)
4-day	**0.052** (0.047-0.059)	**0.065** (0.058-0.074)	**0.080** (0.072-0.092)	**0.092** (0.082-0.106)	**0.108** (0.093-0.127)	**0.119** (0.101-0.143)	**0.130** (0.108-0.160)	**0.141** (0.115-0.177)	**0.155** (0.121-0.201)	**0.165** (0.125-0.221)
7-day	**0.037** (0.034-0.043)	**0.046** (0.042-0.053)	**0.058** (0.052-0.066)	**0.066** (0.059-0.076)	**0.077** (0.067-0.091)	**0.086** (0.073-0.103)	**0.093** (0.078-0.115)	**0.101** (0.082-0.127)	**0.111** (0.087-0.144)	**0.118** (0.090-0.158)
10-day	**0.030** (0.027-0.034)	**0.038** (0.034-0.043)	**0.047** (0.042-0.053)	**0.053** (0.048-0.061)	**0.062** (0.054-0.074)	**0.069** (0.058-0.083)	**0.075** (0.062-0.092)	**0.081** (0.066-0.102)	**0.089** (0.070-0.116)	**0.095** (0.072-0.127)
20-day	**0.021** (0.019-0.023)	**0.026** (0.023-0.029)	**0.032** (0.028-0.036)	**0.036** (0.032-0.041)	**0.042** (0.036-0.050)	**0.046** (0.039-0.055)	**0.050** (0.042-0.061)	**0.054** (0.044-0.068)	**0.059** (0.046-0.077)	**0.062** (0.047-0.083)
30-day	**0.017** (0.015-0.0[illegible]9)	**0.021** (0.019-0.024)	**0.026** (0.023-0.029)	**0.030** (0.026-0.034)	**0.034** (0.030-0.040)	**0.037** (0.032-0.045)	**0.041** (0.034-0.050)	**0.044** (0.035-0.055)	**0.047** (0.037-0.061)	**0.050** (0.038-0.067)
45-day	**0.** (0.013-0.016)	**0.018** (0.016-0.020)	**0.022** (0.020-0.025)	**0.025** (0.022-0.028)	**0.029** (0.025-0.034)	**0.031** (0.026-0.037)	**0.034** (0.028-0.041)	**0.036** (0.029-0.045)	**0.039** (0.030-0.051)	**0.041** (0.031-0.055)
60-day	**0.013** (0.012-0.015)	**0.016** (0.014-0.018)	**0.019** (0.017-0.022)	**0.022** (0.019-0.025)	**0.025** (0.022-0.029)	**0.027** (0.023-0.033)	**0.029** (0.024-0.036)	**0.031** (0.025-0.039)	**0.034** (0.026-0.044)	**0.035** (0.027-0.047)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a

Table 2: Rainfall Intensity for Ferndale, CA

Rainfall Intensity, *i*

Rainfall intensities were selected from intensity-duration-frequency (IDF) curves developed from the NOAA Atlas 14 Point Precipitation Frequency Estimates for Ferndale, table 2. The rainfall intensity is obtained from the IDF curve plot by computing the time of concentration, t_c, and selecting the desired return period. The 25-year storm event was used in accordance with the adopted 1990 Stormwater and Drainage Master Plan recommendation as the basis for the evaluation of existing drainage facilities and the sizing of recommended improvement projects.

Figure 6 shows the intensity of the storm based on the duration of the rainfall. As would be expected, intensity increases as the storm duration decreases. It might rain at a rate of 4.5 inches/hour for 2 minutes but it's very unlikely it continues to rain at that rate for an entire storm.

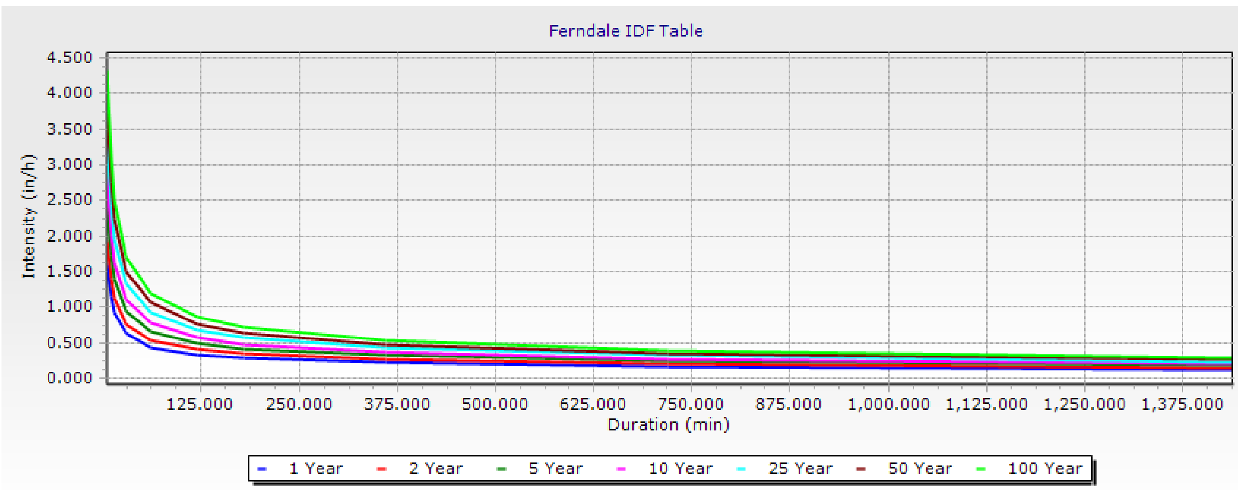


Figure 6: Illustrating the IDF curves for return period of 1 year, 2 year 5 years, 10 years, 25 years, 50 years and 100 years respectively.

Catchment (Drainage) Area

The catchment basin area contributes water to a given drainage inlet. The catchment areas in this analysis were created based on the topography of the land and the location of the inlets. Based on this information, 111 catch basins were established for the City of Ferndale. Catchment areas will be discussed in further detail in the analysis of the East side and West Side Drainage areas.

Time of Concentration: SCS TR-55 Method

The time of concentration is used to calculate the peak discharge and total volume (cfs) for a given catch basin. Peak discharge occurs when all segments of the drainage area are contributing to the runoff from the site. There are many methods available to estimate the hydrology of a storm drain network including the Kirpich formula, Kerby formula, NRCS Upland Method, and NRCS Lag Method and the SCS-TR-55 Method.

For this analysis, the SCS (Soil Conservation Service) TR-55 method was chosen.

Technical Release 55 (TR-55) presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for storm water reservoirs. While this method gives special emphasis to urban and urbanizing watersheds, the procedures apply to any small watershed.

During a storm event, rainfall over a watershed will follow one of three potential paths:

1. It can evaporate into the atmosphere.
2. It can infiltrate into the soil
3. It can hit the ground and eventually make its way into the storm drainage system.

Depending on the total storm rainfall, the slope and roughness of the terrain, the vegetation on that terrain, and the path the rainfall takes on the way to the storm drainage inlet, the travel time T_t for each flow segment within a catchment basin can be calculated. The time of concentration, T_c for one catch basin is the summation of all T_t values for various consecutive flow segments within one catch basin.

$T_c = T_{t1} + T_{t2} + \ldots \; T_{tm}$

Where;

T_c = Time of Concentration (minutes)
T_{tm} = number of flow segments

Rainfall that is not evaporated or absorbed into the ground, travels to the storm drainage system via sheet flow, shallow concentrated flow, channel flow or some combination of the three. The type of flow that occurs is best determined by visual inspection. For this analysis, flow was determined as either sheet flow or shallow concentrated flow. Each type of flow has an associated equation that can be used to calculate the travel time associated with that type of flow.

Sheet Flow

Sheet flow (also called overland flow) is defined as a shallow, unconcentrated and irregular flow down a slope. For this analysis the length of sheet flow does not exceed 300 feet. Once flow reaches pavement/concrete or a drainage channel on a given catch basin, it is regarded as shallow concentrated flow regardless of the length of the sheet flow segment (see definition below). With sheet flow, the friction value (Manning’s n) is an effective roughness coefficient. The n values shown in the figure 7 are for flow at very shallow depths (0.1 feet or less).

Surface Description	n
Smooth Surface (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[1]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[2]	
Light underbrush	0.40
Dense underbrush	0.80

[1] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[2] When selecting n, consider cover to a height of about 0.1 foot. This is the only part of the plant cover that will obstruct sheet flow.

Figure 7: Roughness Coefficients for water during sheet flow

To calculate the travel time during sheet flow, Manning's kinematic solution was used:

$$T_t = \frac{0.007(n\ell)^{0.8}}{(P_2)^{0.5} S^{0.4}}$$

Where,

T_t = Travel Time (Hours)
n = Manning's Roughness coefficient
l = sheet flow length, ft
P_2 = 2 year, 24 hour rainfall, in
S = Slope of land surface, ft/ft

Shallow Concentrated Flow

After water flows approximately 300 feet or hits a roadway or drainage channel, sheet flow becomes shallow concentrated flow collecting in swales, small rills, and gullies. Shallow concentrated flow is assumed to have a flow depth of approximately 0.1 to 0.5 feet.

Because the SCS TR-55 Shallow Concentrated Flow utilizes only two surface types (paved, and unpaved), the NRCS Upland method was used to provide additional flexibility in computing the shallow concentrated flow time of concentration.

The NCRS Upland Method is designed for the computation of T_c of watershed headwaters, including overland flow, grassed waterways, paved segments, and small upland gullies, and is applicable for watershed sub basins of 2000 acres or less. The NRCS Upland Method was published with a log-log graph of velocities versus slope for various surface types. The method is based on the following equation:

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

$$V = K_v\sqrt{S}$$

Where;

T_t = Travel Time (Hours)
L = Flow Length (feet)
V = Average Velocity
K_v = Velocity Factor (See Table)
S = land slope, along flow path (rise/run)

The surface types and corresponding velocity factors were found using the table shown in figure 8 below:

Surface Type	K_v (ft/sec)	K_v (m/sec)
Paved	20.33	6.20
Unpaved	16.13	4.92
Grassed Waterway	15.0	4.57
Nearly Bare & Untilled	10.0	3.05
Cultivated Straight Rows	9.0	2.74
Short Grass Pasture	7.0	2.13
Woodland	5.0	1.52
Forest w/ Heavy Litter	2.5	0.76

Figure 8: Velocity Factors for water during Shallow Concentrated Flow

Chapter 3 - Model Results and Recommendations

3.1 - East Side Drainage Watershed Existing Problem Areas and Recommended Solutions

Five problem areas were identified in the East Side Drainage Watershed. The problem areas and recommended solutions are summarized in the following section.

Problem Area 1: Rose Avenue Culvert (See Map Page C2.13)

This problem area was also included in the 2004 DMPU and has not yet been completed.

The East Side Drainage Channel crosses McKinley Avenue and several adjacent properties through a series of culverts before emptying back into the natural drainage channel. Flow travels through the swale for a short distance before entering a 12-inch CMP culvert located between Watson Avenue and Schley Avenue. The 12-inch culvert crosses several private lots and Rose Avenue before emptying back into the natural channel north of Rose Avenue.

The 12-inch CMP culvert is undersized and does not have the required capacity to accommodate the surface runoff generated by a 25-year storm. This restriction created by the 12-inch CMP culvert causes water to backup upstream of the inlet for some distance, creating a retention pond in the natural drainage channel. Since the 2004 DMPU, the interior condition of the pipe is not known. Based on other CMP pipes located in Ferndale there is a high likelihood that the pipe invert at one or more spots has corroded away. This in turn eventually leads to a full or partial pipe failure which restricts the amount of flow through the pipe.

The 2004 drainage master plan analysis cites a catchment basin for the 12-inch pipe of approximately, 51 acres. Upon further analysis of the topographic map, along with a field visit to the area, it was determined that the catchment basin for this pipe is closer to 9 acres, greatly reducing the amount of water flowing through this area.

For this reason, the 2022 analysis shows that the 12-inch pipe is only slightly undersized. For perspective, a 15-inch CMP is shown to be sized adequately. A 12-inch HDPE pipe is also shown to be sized adequately. There are a few proposed options for this area.

Recommended Solutions:

Option 1: Dig up and replace the roughly 500 feet of old 12-inch CMP and replace it with an 18-inch HDPE pipe. If the work is going to be done to dig up the old pipe, the new pipe should be sized to carry a greater capacity of water. This will require obtaining easements from the property owners and working in narrow areas. Noted in the previous 2004 DMPU, *"At a meeting held on May 21, 2003, the affected property owners acknowledged the severity of the problem and indicated that they would be willing to grant easements to allow for the culvert to be replaced."*

Option 2: There has also been some interest by the Drainage Committee, to explore the option of pipe bursting to increase the size of the pipe. Although usually used on smaller pipes, pipe bursting would increase the diameter of the 12-inch CMP and smooth the interior corrugation of the metal pipe, lowering the friction coefficient. This process would turn the 12-inch CMP to an approximately 15-inch smooth pipe. During a 25-year storm, the 15-inch pipe would be at 50% capacity.

Problem Area 2: Herbert Street Storm Sewer System and Dewey Avenue (See Map Page C2.3)

This problem area was also included in the 2004 DMPU and has not yet been completed. The drainage channel that flows north from Washington Street enters the Herbert Street storm sewer system at the intersection of Herbert Street and Rose Avenue. The Herbert Street storm sewer system runs along the west side of Herbert Street where it joins with the Berding Street storm sewer system at the intersection of Herbert Street, Berding Street, and Fern Avenue. Both of the storm sewer systems discharge into the East Side Drainage Channel through a 48-inch pipe just east of the intersection.

Unlike the 2004 DMPU our analysis of the hydraulic behavior of the Herbert Street storm sewer system indicates that it does have the required capacity to accommodate the runoff from the 25-year design storm. Since the 2004 DMPU several new drainage inlets have bee installed starting at Rose Ave and on Herbert Street. This has helped with localized surface flooding by allowing the surface water to enter into the storm drain system.

Likewise, the 48-inch pipe downstream of the confluence of the Herbert Street and Berding Street storm sewer systems was also found to adequately handle the runoff from a 25-year storm. Therefore, no direct change to the Herbert Street storm drain is proposed.

However, another nearby flooding problem exists on the properties located on the north and south sides of Dewey Avenue. The Lidar data indicates that there is a low spot in Dewey Ave. that occurs about a third of the way between Herbert St. and the East Side drainage channel. This contributes to significant ponding that occurs on several of properties on the south side of the street near the roadway. In addition, a drainage swale exists on the lot situated at the southeast corner of Dewey and Herbert. The channel enters a 6-inch culvert that ties into the Herbert Street storm sewer system. This drainage channel is poorly constructed and has an adverse slope in some sections. Furthermore, the entrance to the 6-inch culvert is located too high to allow the channel to have a continuous positive gradient. Significant ponding occurs along the side adjacent to Dewey Avenue and in the backyard of this property.

During severe storm events, runoff flows across Dewey Avenue and ponds in the low-lying areas of several properties situated north of Dewey Avenue. Ponding reaches depths of several feet in some instances and a house and several garages are subject to periodic flooding. The yards remain flooded until the water has a chance to infiltrate or flow to the East Side Drainage Channel through a 4-inch drainage pipe located on the property situated on the northeast corner of the intersection of Herbert Street and Dewey Avenue.

Recommended Solution

Install a new drainage inlet on the south side of Dewey Ave. at Herbert Street. Install a new 24-inch HDPE pipe from Herbert St. to the East Side drainage channel. Install two new drainage inlets at the low point in Dewey Ave. This would also allow for a future connection to the 36-inch pipe located in Herbert St. if ever required.

Problem Area 3: Berding Street Storm Sewer System at Shaw Avenue (See Map Page C2.5)

This problem area was addressed in the 2004 DMPU, but like the first two problem areas has not yet been corrected.

The Berding Street storm sewer system runs from the intersection of Shaw Avenue to the intersection with Fern Ave. This storm drain is comprised of a 24-inch wide by 15-inch high concrete box culvert. We agree with the 2004 DMPU hydraulic evaluation of the Berding Street storm sewer system that indicates it has the capacity to intercept and convey the flow from a 25-year storm event. However, only a fraction of the storm runoff is directed into the two grate inlets located on the west side of the intersection. A lack of cross slope on the pavement surface on both Shaw Avenue and Berding Street near the intersection results in the street runoff not being directed into the drainage inlets. Instead, the gutter flow traveling down Shaw Avenue and Berding Street spreads out into a sheet across the roadway prior to reaching the intersection and bypasses the storm sewer system. There is a small asphalt dike constructed on the Berding Street grate inlet, but it is not very effective. What is not intercepted by the two grate inlets on Berding Street travels in a northeast direction across the intersection. The flow then travels down Berding Street a short distance before flowing east down Rose Avenue. This carryover ends up creating flooding problems at the intersection of Rose Avenue and Herbert Street across from the Farm Shop where it enters the Herbert Street storm sewer system.

Recommended Solution

Install a new 12-inch HDPE pipe on the south side of Shaw Avenue from Berding Street to Main Street. Install a new drainage Inlet at the southeast corner of Shaw Ave and Main Street and possible another drainage inlet midway between Main and Berding Streets. These two new drainage inlets will catch the majority of the surface flow on Shaw Ave before it reaches the drainage inlet at Berding Street. It will also alleviate downstream flooding issues on Rose Avenue.

Problem Area 4: Berding Street Storm Sewer System at Herbert street (See Map Page C2.4)

At the end of the Berding Street Storm Sewer System at Fern Ave, it crosses Berding Street and connects to the Herbert Street Storm Sewer System. This connecting pipe is a 15-inch CMP and is undersized for the 25-year event. This can potentially cause a backup in the Berding Street Storm Sewer System.

Recommended Solution

Replace the 15-inch CMP pipe with a new 24-inch HDPE pipe.

Problem Area 5: Ambrosini Lane Culvert (See Map Page C2.10 – C2.11)

The Ambrosini Lane culvert on the south side of Ambrosini Lane conveys storm runoff from the East Side Channel up to Ambrosini Lane. The culvert inlet is located just inside the city limits on private property approximately 300 feet south of Ambrosini Lane. The culvert outlet discharges just south of Ambrosini Lane where it transitions to a 48-inch CMP pipe that goes across Ambrosini Lane. From there it enters into a County ditch that flows north towards Highway 211. The culvert is approximately 300 feet in length and is a 36-inch concrete arched culvert pipe. The culvert does not have the hydraulic capacity to convey storm water from a 25-year storm event.

Recommended Solution

Option #1: Replace the 36-inch concrete arched culvert with a new 48-inch pipe.

Option #2: Keep the 36-inch concrete arched culvert and add a new 36-inch HDPE pipe.

Either option will require the acquisition of easements to install new culvert pipes.

3.2 - West Side Drainage Watershed Existing Problem Areas and Recommended Solutions

Problem Area 1: 5th Street at Milky Way (See Map Page C3.3)

A drainage problem exists on 5th Street at Milky Way. During a mild storm event in December of 2021, substantial flooding was witnessed at the intersection of Milky Way and 5th street. Water had ponded in the small drainage channel that runs along Milky Way and was spilling out into 5th Street. Because there is no drainage infrastructure at this location, there was substantial flooding on the street. The slope on 5th street is so mild in this location that the water does not adequately drain north towards the newly installed drainage inlets (recommended per the 2004 DMPU) near Fairway Drive Loop.

Recommended Solution

Install a new drainage inlet at the intersection of 5th Street and Milky Way. Install a new 18-inch HDPE pipe north on 5th Street (east or west side) to the existing swale located across from Fairway Drive Loop. Optionally, also install a new 12-inch HDPE pipe east along the ditch on Milky Way with a new drainage inlet at the eastern end.

Problem Area 2: Arlington Avenue at 5th Street (See Map Page C3.7 – C3.9)

This problem area was listed in the 2004 DMPU as the Humboldt County Fairgrounds and has not yet been constructed.

The Humboldt County Fairground's storm sewer system collects runoff from the Fairgrounds property and conveys runoff from portions of Arlington Avenue and 5th Street, and the undeveloped area south of Arlington Avenue. Two drainage inlets are located on Arlington Avenue. The western inlet has a 8-inch pipe crossing Arlington and the eastern inlet has a 12-inch pipe. The 8-inch pipe appears to openly discharge onto the fairground's property. The 12-inch pipe continues into the fairgrounds but appears to be clogged somewhere down the line. The Fairgrounds storm sewer system ultimately discharges into a roadside drainage ditch on the south side of Van Ness Avenue. Flooding commonly occurs around drainage inlets on the Fairgrounds property. The existing 12-inch conveyance culvert through the fairgrounds lacks the capacity to handle a 25- year storm event and frequently floods during smaller events. A hydraulic analysis of both existing culverts indicates that they are undersized. In addition to being undersized, the system appears to have lost capacity from sediment deposition in the pipelines.

Recommended Solution

Abandon the storm drain system within the Humboldt County Fairgrounds. Replace the two existing storm drain inlets on Arlington Ave. with new inlets. Starting at the east inlet install a new 18-inch HDPE pipe west to the western inlet. Install a 24-inch HDPE pipe from the western inlet to the intersection of 5th street. Install new drainage inlets at the corner on both sides of Arlington Ave. Install a new 24-inch HDPE pipe from Arlington Ave. to just north of the Fairgrounds parking lot along the 5th Street extension. Improve the ditch along the remainder of 5th Street to the existing 24-inch RCP culvert that crosses Van Ness Ave.

This will alleviate flooding on the fairground's property due to drainage from the City of Ferndale.

3.3 - Outside City Limits

From the West Side Drainage Area, storm water exits the city limits and travels north to the Salt River through three main routes: Rasmussen Lane, the 5th Street Exit, and California Street. From the East Side Drainage storm water exits the city limits at Arlington Ave. and Market Street. Analyzing these drainage routes is currently outside the scope of this report. The City is actively seeking grants to help fund the analysis and design of drainage infrastructure outside of the City limits.

Chapter 4 - Funding Considerations and Recommendations

4.1 - Funding

The three basic means of obtaining funds for storm water maintenance and improvement projects are Property Assessment Districts, Development Fees, and grants. The City of Ferndale has an existing Drainage Assessment and charges Developer Fees.

Property Assessment

In the November 1997 election, the voters approved Measure V which established a Drainage Assessment District within the City Limits of Ferndale with the authority to assess each parcel a $25 annual drainage fee. The voters approved the passage of Measure V with the knowledge that the Lytel Foundation (a local non-profit organization) would pay $25,000 per year in lieu of the $25 per parcel annual fee. This donation was made annually until recently. Currently, each parcel is charged the $25 fee on their annual tax bill administered by Humboldt County. With approximately 780 parcels within the City, this results in an annual revenue of $19,500.

Since 2002, the annual drainage budget has included a $13,555 payment to Tri-Counties Bank for a loan that covered the matching funds for the FEMA grant obtained to repair flood damage. This loan is set to be paid off in August 2022. This will increase the amount of funding available for annual drainage related improvements. However, it is not enough to cover the total annual cost of maintenance or build up reserves for future drainage projects. Conducting a new rate study and obtaining an updated Engineer's Report, would help determine an annual assessment that would support annual maintenance and provide revenue for larger drainage improvement projects.

Drainage Impact Development Fees

In 1994, the City adopted a Storm Drainage Fee Ordinance which established fees on new subdivisions and building permits. Development Drainage Fees are currently assessed at a rate of $1,500 per new residence or building. The fee for additions to existing parcels which result in increased ground coverage or additional floor area in excess of 100 square feet is $0.50 per square foot. New graveled roadways or parking areas in excess of 100 square feet are subject to a fee of $0.35 per square foot. The total fee for any one addition or improvement is not to exceed $500.

Commercial and industrial developments on existing parcels are charged a fee of $0.50 per square foot of impervious area created with a maximum fee of $15,000 per acre. The fee for new parcels created which are zoned commercial or industrial are pro-rated at a rate of $15,000 per acre.

GRANTS

The City continues to search and apply for grants that may be able to fund drainage improvement projects. The City is currently working with the State Water Resources Control Board through their Stormwater Technical Assistance Program to further develop project designs for 5th Street and Van Ness Avenue. This project, if constructed, would improve drainage from Arlington Avenue to 5th Street and discharge water to a detention basin or infiltration field just north of Van Ness Avenue outside of the City limits.

Additional grant efforts include a recent application that was submitted under the California State Parks Proposition 68 Rural Recreation and Tourism Program. The proposed project would upgrade the existing RV park adjacent to the county fairgrounds and construct stormwater drainage improvements along 5th Street. While not specifically a stormwater grant, the project was able to incorporate stormwater/ drainage improvements that would benefit a larger area. It may be possible to use this approach with other funding programs and should be utilized where possible.

4.2 - Recommendations

It is recommended that this Drainage Master Plan Update be adopted by the City Council to better address the current state of storm water drainage in the City of Ferndale. Additionally, the City Council is encouraged to pursue regular evaluation of funding options, including the drainage property assessment, in order to cover increasing costs of maintenance and to fund improvement projects.

FUNDING

Based on an initial assessment of current funding mechanisms, it is recommended that the City consider an update its current annual property assessment. This is typically done by conducting a 218 process which involves obtaining an Engineer's Report that details the existing costs of the system and revenue structures that would cover those costs. During this process, Ferndale residents would be given ample time to provide comment on the new assessment structure before it is placed on a ballot for final approval. By restructuring the assessment, the City would be able to fund maintenance of the citywide system and build up reserves for larger drainage improvement projects.

The City may also want to consider reviewing the current development impact fees to insure the adequately cover the costs of impacts and align with other municipalities in the region. Update of the impact fees would be accomplished by passing a new ordinance to replace the original one set in 1994. Grant funding should also be pursued as staff time allows.

RECOMMENDED DRAINAGE IMPROVEMENT PROJECTS

The seven projects in the project priority list (Table 3) should be implemented as drainage funds become available. The projects are listed in order of their priority. The factors considered in determining priority were the extent and frequency of flooding and the potential for property damage. The project descriptions and estimated costs are listed in Table 3 below. Any easements required for the projects should be acquired as soon as possible either through purchase, as a condition of development, or as condition of benefit resulting from the implementation of such projects.

RECOMMENDED PROJECT PRIORITY LIST

		Est. Cost
1	At Berding & Herbert Streets Replace (E) ±15"CMP pipe with 50't of New 24-inch HDPE pipe	$21,000
2	At Berding St. & Shaw Ave. Install ±305' of 12-inch HDPE and drainage inlets.	$83,580
3	At Dewey Ave. Install ±460' of 24-inch HDPE pipe and drainage Inlets from Herbert St. to the East Side Drainage Channel	$204,300
4	At Rose Ave. Replace (E) 12" CMP with ±505' of 18-inch HDPE pipe. Will require obtaining easements and working in narrow areas. Estimated cost does not include the cost to acquire easements.	$193,980
5	At 5th St. & Milky Way, Install ±550' of HDPE pipe from Milky Way to Drainage Channel with drainage inlets	$236,340
6	At Ambrosini Lane, Install ±325' of 36-inch HDPE pipe. Will require obtaining easements.	$109,200
7	At Arlington Ave at 5th St. Install ±1800' of 18-inch & 24-inch HDPE pipe from Arlington Ave. to Van Ness Ave.	$575,460
	TOTAL	$1,423,860
	Note: Estimated costs include design, bidding, and construction management in 2022 dollars (see Appendix A)	

Table 3: Recommended Project Priority List

OUTSIDE CITY LIMITS

The city will continue to cooperate with the County and other partners on the development of stormwater drainage facilities in the area. The City recognizes that taking a regional approach to stormwater management will provide additional benefits to sensitive ecosystems and promote overall watershed health.

Appendix A – Cost Estimates

ROSE AVENUE CULVERT

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL PRICE
	Mobilization / Demobilization	1	ls	$12,000.00	$12,000.00
	Drainage Inlet	1	ea	$5,000.00	$5,000.00
	18" Drainage Pipe	375	lf	$150.00	$56,250.00
	18" Drainage Pipe - Under Concrete / AC	130	lf	$180.00	$23,400.00
	Added Cost for Excavating Near Houses	1	ls	$30,000.00	$30,000.00
	Design, Bidding and Construction Management	1	ls	$35,000.00	$35,000.00
	20% Contingency	1	ls	20%	$32,330.00
	TOTAL ROSE AVENUE CULVERT				**$193,980.00**

HERBERT STREET STORM SEWER SYSTEM AND DEWEY AVENUE

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL PRICE
	Mobilization / Demobilization	1	ls	$12,000.00	$12,000.00
	Drainage Inlet	3	ea	$5,000.00	$15,000.00
	Headwall	1	ea	$5,000.00	$5,000.00
	12" Drainage Pipe - Under AC	75	lf	$130.00	$9,750.00
	24" Drainage Pipe - Under AC	460	lf	$200.00	$92,000.00
	Design, Bidding and Construction Management	1	ls	$36,500.00	$36,500.00
	20% Contingency	1	ls	20%	$34,050.00
	TOTAL HERBERT ST STORM SEWER SYSTEM AND DEWEY AVE				**$204,300.00**

BERDING STREET STORM SEWER SYSTEM AT SHAW AVENUE

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL PRICE
	Mobilization / Demobilization	1	ls	$5,000.00	$5,000.00
	Drainage Inlet	2	ea	$5,000.00	$10,000.00
	12" Drainage Pipe - Under AC	305	lf	$130.00	$39,650.00
	Design, Bidding and Construction Management	1	ls	$15,000.00	$15,000.00
	20% Contingency	1	ls	20%	$13,930.00
	BERDING STREET STORM SEWER SYSTEM AT SHAW AVENUE				**$83,580.00**

BERDING STREET STORM SEWER SYSTEM AT HERBERT STREET

ITEM	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL PRICE
	Mobilization / Demobilization	1	ls	$2,000.00	$2,000.00
	24" Drainage Pipe - Under AC (Remove (E) Pipe)	50	lf	$250.00	$12,500.00
	Design, Bidding and Construction Management	1	ls	$3,000.00	$3,000.00
	20% Contingency	1	ls	20%	$3,500.00
	BERDING ST STORM SEWER SYSTEM AT HERBERT ST				**$21,000.00**

AMBROSINI LANE CULVERT					
ITEM	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT COST**	**TOTAL PRICE**
	Mobilization / Demobilization	1	ls	$6,500.00	$6,500.00
	36" Drainage Pipe	325	lf	$200.00	$65,000.00
	Design, Bidding and Construction Management	1	ls	$19,500.00	$19,500.00
	20% Contingency	1	ls	20%	$18,200.00
	AMBROSINI LANE CULVERT				**$109,200.00**

5TH STREET AT MILKY WAY					
ITEM	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT COST**	**TOTAL PRICE**
	Mobilization / Demobilization	1	ls	$12,000.00	$12,000.00
	Drainage Inlet	4	ea	$5,000.00	$20,000.00
	12" Drainage Pipe	310	lf	$110.00	$34,100.00
	24" Drainage Pipe (at shoulder on east side of 5th St.)	505	lf	$170.00	$85,850.00
	24" Drainage Pipe - Under AC	40	lf	$200.00	$8,000.00
	Design, Bidding and Construction Management	1	ls	$37,000.00	$37,000.00
	20% Contingency	1	ls	20%	$39,390.00
	5TH STREET AT MILKY WAY				**$236,340.00**

ARLINGTON AVENUE AT 5TH STREET					
ITEM	**DESCRIPTION**	**QTY**	**UNIT**	**UNIT COST**	**TOTAL PRICE**
	Mobilization / Demobilization	1	ls	$28,000.00	$28,000.00
	Drainage Inlet	6	ea	$5,000.00	$30,000.00
	18" Drainage Pipe - Under AC	660	lf	$180.00	$118,800.00
	24" Drainage Pipe	750	lf	$170.00	$127,500.00
	24" Drainage Pipe - Under AC	400	lf	$200.00	$80,000.00
	Drainage Ditch upgrade	270	lf	$75.00	$20,250.00
	Design, Bidding and Construction Management	1	ls	$75,000.00	$75,000.00
	15% Contingency	1	ls	20%	$95,910.00
	ARLINGTON AVENUE AT 5TH STREET				**$575,460.00**

[i] Humboldt County, Revised Draft Environmental Impact Report – 3.8 Geology and Soils. April 20, 2017.
[ii] California Department of Conservation, Geologic Map of California, 2010. Accessed August 1, 2019 from http://maps.conservation.ca.gov/cgs/gmc/.
[iii] USDA, Natural Resources Conservation Service, Web Soil Survey. Accessed August 1, 2019 from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.
[iv] National Weather Service Forecast Office – Eureka, CA, Climatological Report (Annual), January 1, 2019.
[v] Humboldt LAFCo, City of Ferndale Municipal Service Review, November 2018, pg. 23.
[vi] USGS, National Water Information System: Web Interface. Historical data for USGS 11479560 Eel R A Fernbridge CA for January 1-31, 2017.
[vii] USGS, 2018-2019 Lidar: Northern California Wildfire – QL1. Published 10-1-2019.