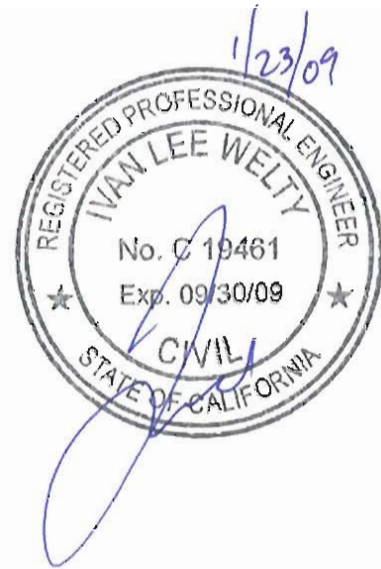


Drainage and Flood / Storm Investigation

Navarro-by-the-Sea Center
Navarro River Redwoods State Park



Report prepared by

I.L. Welty & Associates
703 N. Main Street
Fort Bragg, CA

March 2008

Revised December 2008

Drainage and Flood / Storm Investigation

The study site is located on the Navarro River where it reaches the Pacific Ocean in California. We have focused on the drainage areas that affect the historic buildings within the study area. This area begins northeast of the Mill house and continues southwest approximately 400 feet to the Navarro-by-the-Sea Inn.

Site Drainage Conditions

The general slope is from southeast to northwest and is an average slope of 30% in 1300 feet. As the terrain approaches the site and the Navarro River the slope increases to approximately 80% near the east side of the Navarro by the Sea Inn.

Drainage in the water shed has been interrupted and channeled by the existing State Highway 1 and once again by the old State Highway 1 which was located approximately 110 feet southeast and 70 feet above the Inn. The drainage is then interrupted a third time when it reaches Navarro Beach Road the roadway that parallels the Navarro River immediately northwest of the Inn. There are three separate drainage features in route to the Navarro study area. The old state highway is overgrown and still has sections of asphalt surfacing. The drainage on this old roadway cuts off the natural cross drainage and in general channels the drainage in a ditch on the uphill side and slopes to the northeast until it crosses Navarro Beach Road. We have labeled this "Drainage A". (see plate 1)

Much of the storm water does not drain the entire distance and makes it down to the south side of the Mill House. The drainage crosses the roadway in a storm drain that is filled with sediment. We have labeled this "Drainage B".

The third drainage area and most significant begins approximately ¼ of a mile east of the Inn. The water shed is routed under state highway 1 via a storm drain. The drainage then follows a steep ravine down to the old state highway 1 where it enters a 5' x 5' square wood cribbed 20 foot deep drop inlet. The storm water is then directed via a 36 inch diameter storm drain and terminates in a shallow ditch near the east corner of the Inn. We have labeled this "Drainage C".

The 36 inch storm drain system that once transported the drainage across the roadway and into the river is completely silted in. The old parking lot near the north corner of the Inn has been taken over and has become a wetland/riparian area. During high rainfall the water most likely floods the roadway as well as the foundation of the Inn. Surface water flows northeast through the establishing wetland riparian area and passes under Navarro Beach Road through a 24 inch culvert, approximately 300 feet northeast of the Inn. This culvert is heavily silted in and partly obstructed due to poor maintenance.

Hydrology

We have developed hydrology data for the three drainage areas and have included information for a 10-year and 100-year storm. We have used the rational method along with local rainfall intensity curves and local knowledge of runoff coefficients.

We have included a hydrology area map labeled Plate P2 where we have identified 8 sub-areas that contribute to the drainage outlets A, B and C.

Drainage outlet “A” includes sub areas 6 and 7, drainage outlet “B” includes sub-areas 4 and 5 and drainage outlet “C” includes sub-areas 1, 2 and 3. We have used a time of concentration of 20 minutes for all areas and have produced data for both a storm event of occurring every 10 years and a storm event that occurs every 100 years.

| Drainage Outlet | Area Acres | Q | Q |
|----------------------|-------------|---------------|----------------|
| | | cfs 10 yr. | cfs 100 yr. |
| <u>A (6&7)</u> | <u>7.5</u> | <u>3.6</u> | <u>5.63</u> |
| <u>B (4&5)</u> | <u>9.5</u> | <u>4.56</u> | <u>5.86</u> |
| <u>C (1,2&3)</u> | <u>22.6</u> | <u>10.85</u> | <u>16.96</u> |

Flooding, Storm Action & Tsunami Potential

When looking at all the elements of flood and storm action, this study area is one of the most difficult. Attached to this report is a Flood Insurance Rate Map (FIRM) produced by The Federal Emergency Management Agency (FEMA) This firm shows the access road in front of and north of the Inn in a Zone A area, this indicates that it is in a 100-year flood zone however no elevation has been determined.

The development of these zones where a river meets the ocean has modeled the event at mean sea level and has not considered the effects of storm surge, high tides or tsunami.

The 100-year flood elevation is assumed to be around 10 or 11 feet above mean sea level as determined by N.A.V.D.88 datum. An extreme high tide could be around 8 feet. The FIRM does not indicate a high storm wind area for the study area. However historical evidence indicates that some value should be placed on surge from storms. Historically drift wood and logs wash up on the roadway in front of the Inn.

The geotechnical hazard zones as shown in the Mendocino County General Plan Seismic Safety Element does not label the study area as one of its tsunami hazard locations however, the geotechnical Hazard zone I that is defined by the San Andreas Fault is considered medium to high potential on the Hazard Zone Chart.

The most recent information on tsunamis for our study area has been published by California Geological Survey. In this publication they discuss tsunamis developed from local sources and from distant sources. For local sources the publication says that earthquakes south of Cape Mendocino take place mainly on strike – slip faults, and because the movement they generate is mostly lateral, tsunamis from local sources are less likely to occur because the ocean floor and overlying water is not typically thrust upward. From distant sources the most devastating tsunami to affect California in recent history was from the magnitude 9.2 Alaskan earthquake of 1964. Areas of Northern California experienced a six-meter (20' foot) tsunami wave that flooded low-lying communities, such as Crescent City. This earthquake tsunami was recorded at Point

Arena as 1.8 meter (5.4 feet). The 2004 Sumatra tsunami caused a sea level fluctuation in San Diego of 8.5 inches one day later.

Since the local source tsunami is unlikely, we have selected a design distant source tsunami elevation of 6 feet for this study area.

The maximum geotechnical hazard elevation should consider a combination of a mean tide and the 100 year flood elevation. This elevation should be considered on the order of 14 feet above sea level.

Recommendations

Drainage "A":

The biggest portion of drainage "A" is directed to the lower access road via a storm drain from Caltrans state highway 1. Some of the storm water runs along the uphill ditch on the old state highway and drains the area up to the highway 1 roadway.

The existing 24 inch culvert for drainage "A" needs to be cleaned and the ditches regraded.

Drainage "B":

The areas that makes up drainage "B" starts east of State Highway 1. The drainage is interrupted by erosion and slope failures on the old state highway in route to the Navarro Beach Road.

We recommend that the existing 8 inch culvert under Navarro Beach Road be replaced with a 12 inch culvert and the drainage ditches be regraded to accommodate the culvert. The roadway ditches will need to be regraded between drainage "C" and the new 12 inch storm drain at drainage "B".

Drainage "C":

This drainage also comes in part from the east side of Highway 1 and represents the greatest threat to the historic Inn. It is our understanding that a new foundation is scheduled to be placed under the Inn building. In order to get adequate separation from both the nearby storm drain and storm water from the ocean side, we recommend extending the stem wall and raising the floor level three feet above existing grade.

If the old parking area that has been taken over as a wetland/riparian area needs to remain or be enhanced, we recommend the soil be graded away from the Inn and the slope protected with small rock rip-rap. We also recommend cleaning the existing 24 inch culvert under Navarro Beach Road and regrading to adequately drain the area. This culvert needs to be routinely maintained and silt removed. The completely silted 36" culvert that once drained the area can be abandoned given the ongoing problems with silting in by storm surges in the river.

Storm water protection:

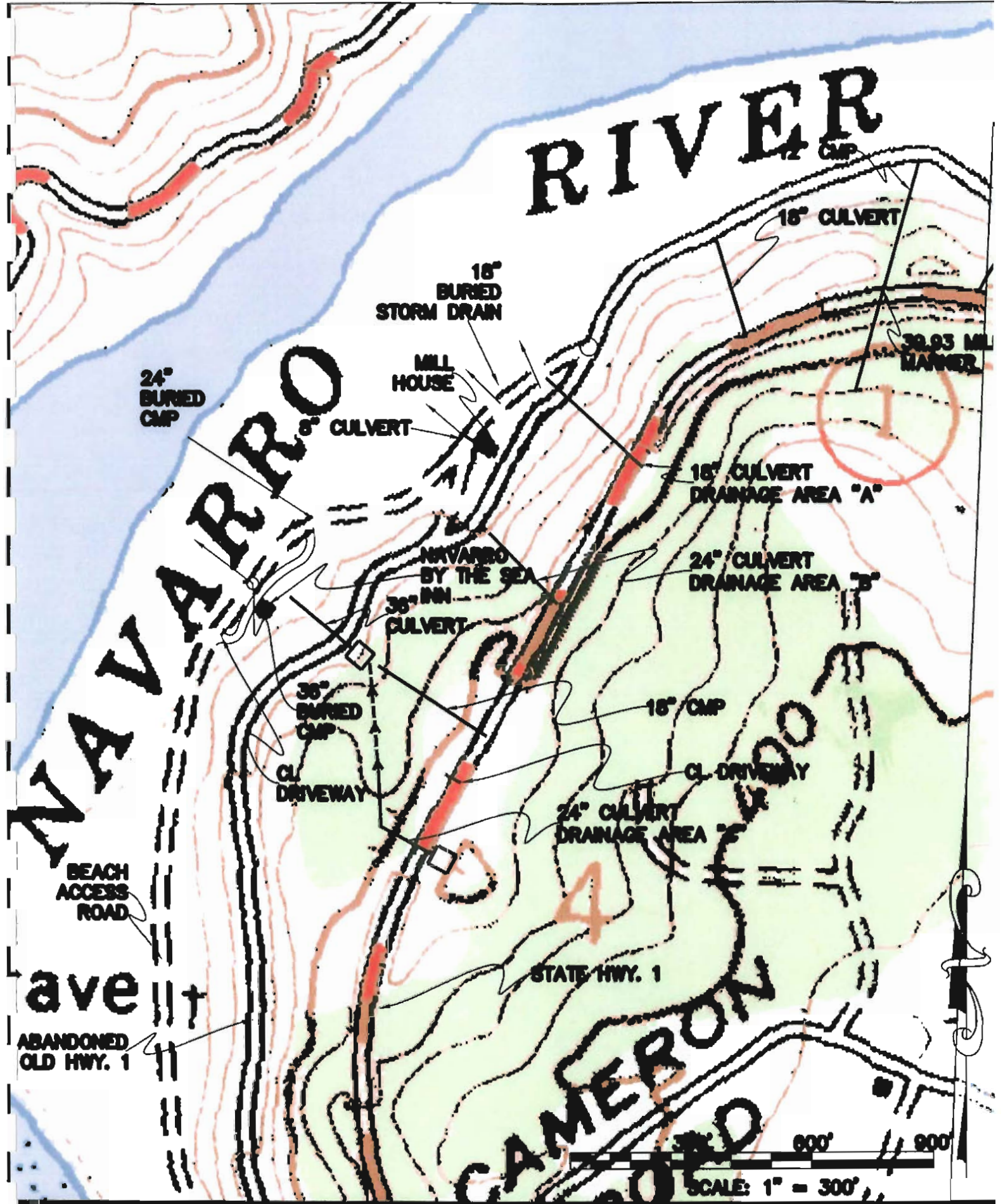
Storm water damage from the river side is mostly considered a problem at the west end of the Inn building.

We recommend that rip-rap be placed as needed along the northwest side of Navarro Beach Road where erosion has taken place. The severely eroded length of

approximately 30 feet was reportedly repaired in the summer of 2008 after our initial report.

We also recommend that large rip-rap boulders or other bollard system be placed northwest of the roadway and west of the Inn in order to lessen the chance of floating debris and logs from damaging the Inn during storm surges.

RIVER



| | | | |
|----|----------|------|--------------------|
| P1 | REVISION | DATE | JOB 07007 |
| | | | DRAWN TH |
| | | | DATE 4/2008 |
| | | | SCALE: 1" = 300' |
| | | | APPROVED RCE#19461 |

HYDROLOGY DRAINAGE FEATURES
 NAVARRO BY THE SEA
 A PORTION OF NAVARRO RIVER REDWOODS
 STATE PARK
 ALBION, CA



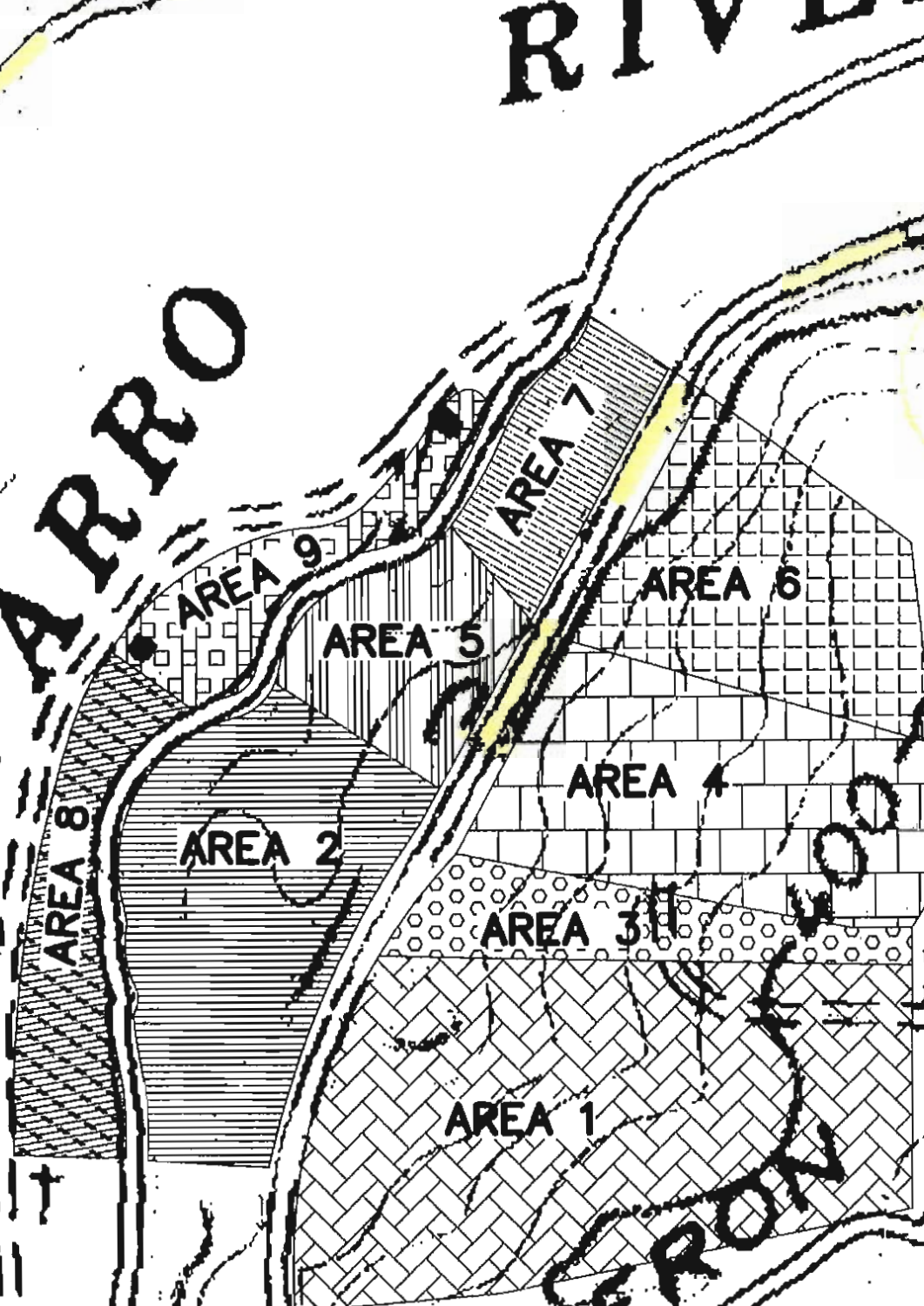
I.L. Welty & Associates
 703 North Main Street
 Fort Bragg, California 95437
 (707) 964-8865 (707) 964-5920 Fax
 www.itwelty.com

RIVER

NAVARRO

ave

CAMERON ROAD



| | | | | |
|----|-------|----------|------|------------------------|
| P2 | PLATE | REVISION | DATE | JOB: 07007 |
| | | | | DRAWN TH |
| | | | | DATE 4/2008 |
| | | | | SCALE: 1"=300' |
| | | | | APPROVED RCE #19461 |

HYDROLOGY AREA MAP
 NAVARRO BY THE SEA
 A PORTION OF NAVARRO RIVER REDWOODS
 STATE PARK
 ALBION, CA



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AREA DISCHARGE

| Damage Area * | Area Access | Tc min. | I 10 inch/hr | I 100 inches / hr | Run-off C | Q10 | Q100 |
|------------------|-------------|---------|--------------|-------------------|-----------|------|------|
| 1 | 13.0 | 20 | 1.6 | 2.5 | 0.3 | 6.24 | 9.75 |
| 2 | 7.1 | 20 | 1.6 | 2.5 | 0.3 | 3.41 | 5.33 |
| 3 | 2.5 | 20 | 1.6 | 2.5 | 0.3 | 1.20 | 1.88 |
| 4 | 7.0 | 20 | 1.6 | 2.5 | 0.3 | 3.36 | 5.25 |
| 5 | 2.5 | 20 | 1.6 | 2.5 | 0.3 | 1.20 | 1.88 |
| 6 | 5.3 | 20 | 1.6 | 2.5 | 0.3 | 2.54 | 3.98 |
| 7 | 2.2 | 20 | 1.6 | 2.5 | 0.3 | 1.06 | 1.65 |
| 8 | 2.9 | 20 | 1.6 | 2.5 | 0.3 | 1.39 | 2.18 |
| 9 | 2.2 | 20 | 1.6 | 2.5 | 0.3 | 1.06 | 1.65 |

* See Plate P2 for area map

RIVER

CLEANOUT (E) 18" CMP
 REPLACE 8" CMP
 w/ 12" CMP

CLEANOUT (E) 24" CMP
 SETTLING BASIN
 WETLAND/RIPARIAN
 AREA

RIP-RAP
 INN
 PROTECTION

RIP-RAP
 ROAD
 PROTECTION

(E) INN/
 RAISE FLR.

ave

(E) 36" CMP

CAMERON
 ROAD

| | | | | |
|-----|-------|----------|------|-----------------------|
| P 4 | PLATE | REVISION | DATE | JOB 07007 |
| | | | | DRAWN TH |
| | | | | DATE 4/2008 |
| | | | | SCALE: 1"=300' |
| | | | | APPROVED RCE#19461 |

AREA OF REPAIR
 NAVARRO BY THE SEA
 A PORTION OF NAVARRO RIVER REDWOODS
 STATE PARK
 ALBION, CA



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APPROXIMATE SCALE



NATIONAL FLOOD INSURANCE PROGRAM

FIRM FLOOD INSURANCE RATE MAP

MENDOCINO COUNTY, CALIFORNIA (UNINCORPORATED AREAS)

PANEL 750 OF 1100
(SEE MAP INDEX FOR PANELS NOT PRINTED)

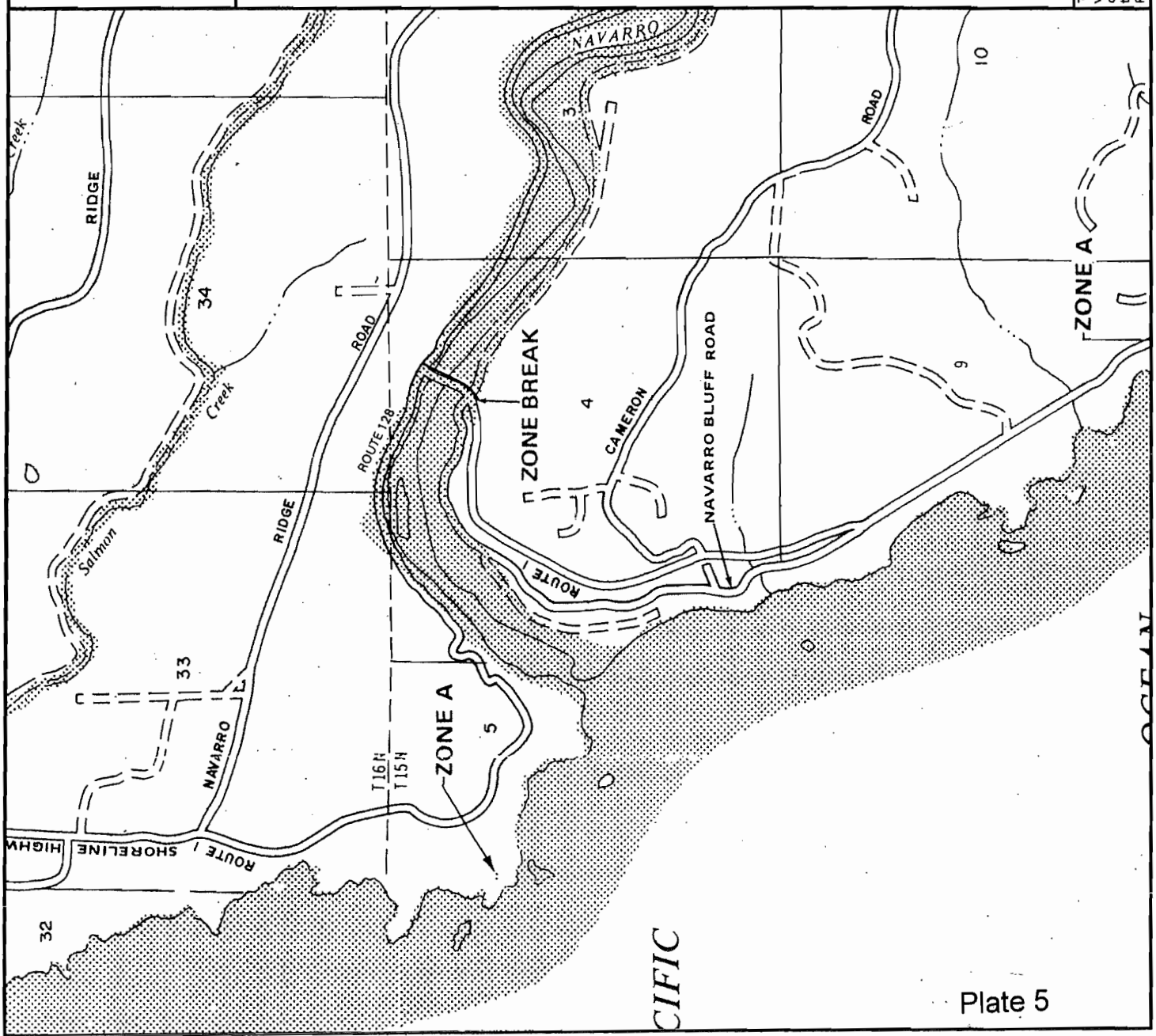
COMMUNITY-PANEL NUMBER
060183 0750 B

EFFECTIVE DATE:
JUNE 1, 1983



Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1979

STATION F80 3161 0

MENDOCINO COUNTY

SEC 06. T18N. R17W. MOUNT DIABLO BASE AND MERIDIAN

LAT 39.446 LONG 123.507

ELEV 80

COEFFICIENT OF DETERMINATION = 0.998

FREQUENCY OF OCCURRENCE (YEARS)
1.0 0.00 100 50 25 10 2

NOTE. THESE CURVES REPRESENT ANALYSIS OF DATA DURATIONS OF 5 MIN TO 3 HOURS BASED UPON PEARSON TYPE III DISTRIBUTION

50
40
30
20
10
8.0
6.0
5.0
4.0
3.0
2.0
1.0
0.8
0.6
0.5
0.4
0.3
0.2
0.1

INTENSITY (INCHES/HOUR)

5 6 7 8 9 10 12 16 20 30 40 50 1 2 3 4 6 8 10 12 16 20 24

MINUTES → HOURS
DURATION

Rainfall Intensity Curves

Average Velocities for Estimating Travel for Overland Flow

Figure IV-2

