SECTION C
HYDROLOGY

INTRODUCTION

This section provides the available river peak flow data for the Navarro River the watershed adjacent to the Greenwood WAU and information collected on watershed size for perennial and intermittent watercourse observations. The peak flow data is used to show the magnitude of storm events and when they occurred. High river peak flow events are indicative of the largest storms, with large storms typically comes high erosion and sediment transport events. The Navarro River peak flow data was the only long term river flow data available in close proximity to the Greenwood WAU. The Navarro River peak flow data probably does not provide a direct relationship with the peak flows of the Greenwood Creek. However, for the purpose of showing the timing and magnitude of large storm events of the area, the Navarro River peak flow data is assumed to be sufficient.

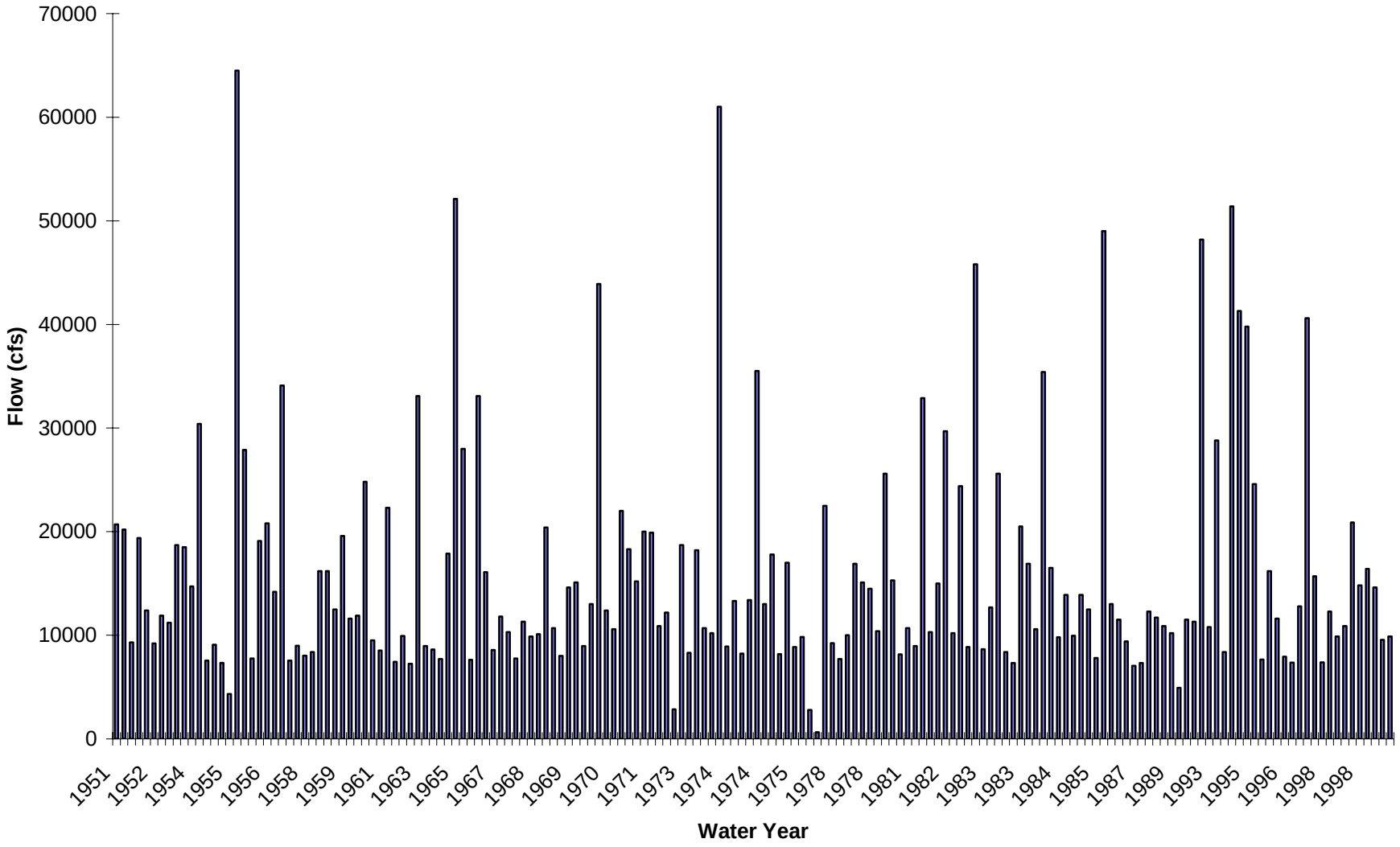
Peak Flows

The peak flow information was taken from the United States Geological Survey (USGS) gage 11468000, Navarro River near the ocean, from water years 1952-2002. All peak flows greater than base flow (7000 cfs) are shown over the period of record (Figure C-1). To estimate the recurrence interval of the flood events of the Navarro River the USGS annual peak flow series was used. An extreme value type I distribution (Gumbel, 1958) was fitted to the data. Table C-1 shows the estimated recurrence interval for peak discharges in the basin.

Table C-1. Flood Recurrence for Peak Flows of the Navarro River, 1952-2001.

Recurrence Interval (years)	Peak Discharge (cfs)
2	19687
5	33431
10	42531
25	54028
50	62558
100	71024

Figure C-1. High Peak Flows (above base flow) for Navarro River, 1951-2002



Using the peak flow record from 1952-2002, the flood of record is 1955 (64,500 cfs) considered to be greater than a 50 year event for the Navarro River (Table C-1). In the last decade alone there has been 2 storms greater than a 10 year recurrence (1993 and 1995), 5 storms greater than a 5 year recurrence (1993, 1995(3) and 1998) and 8 storms greater than >2 yr. recurrence. This indicates a high number of extreme storms occurring within the last decade. The high occurrence of these extreme storms in the last decade suggests that the Greenwood WAU has been subjected to stressful hydrologic conditions, possibly creating a greater incidence of landslides, road failures or surface erosion.

Throughout the last 40-50 years in the Navarro there have been numerous large flood events (>2 year recurrence, Figure C-1). These flood events have the capacity to re-shape river or stream channels and transport large sediment loads. The meteorological events which created these large floods also can be assumed to be a major contributor to the erosion and mass wasting delivered to the watercourses in the WAU.

Perennial versus Intermittent Watercourses

Currently MRC designates a small Class II watercourse as one with less than 100 acres of watershed area. This designation was determined in absence of field observations and is meant to be a reasonable watershed size for the break between perennial (surface water all year) and intermittent (surface water during the winter) watercourses across the MRC lands. MRC provides greater protection on Class II watercourses with perennial flow (Large Class II watercourses) because the greater significance for summer season aquatic habitat.

As part of MRC's monitoring efforts on the effectiveness of Large and Small Class II watercourse protections an evaluation of the watershed size for a perennial watercourse was performed in the Greenwood WAU. This evaluation is meant to be the starting point for assessment of whether 100 acres is a reasonable watershed size for differentiating Large and Small Class II watercourses. The next step will be to assess the effect stream temperature may be influenced by canopy retention along Small Class II watercourses. The combination of perennial stream flow and stream temperature effect of forest management will adjust the Small Class II watershed area designation either up or down.

In the Greenwood WAU many watercourses with watershed size of 100 acres or less were visited. The watercourses visited were the most accessible watercourses and distributed throughout the Greenwood WAU. When a watercourse was visited in the field the observer walked up the watercourse until significant surface water was no longer in the watercourse. Significant surface water covers at least 25% of the channel length in 100 ft sections with water depth $\geq$ 0.05 feet (15 mm).

Table C-2 shows the results of the observations for perennial surface water in the Greenwood WAU. The area is given for each site observed and whether it is spring fed or not. If the observed site had its break of perennial surface water at a confluence of two watercourses this is noted in Table C-2 as a maximum area for the watercourse. It is considered a maximum area because any additional distance downstream encompasses a watershed area for an additional watercourse.

Table C-2. Perennial Surface Water Watercourse Observations for Greenwood WAU
(site locations shown on Map E-1 of the Stream Channel Condition section of this watershed analysis).

Site Number	Date Observed	Area(ac)	Maximum Area	Spring Fed?
1	9/22/2003	64	Yes	No
2	9/22/2003	26	No	Yes
3	9/22/2003	115	Yes	No
4	8/27/2003	70	No	Yes
5	8/27/2003	38	Yes	No
6	8/27/2003	51	Yes	No
7	8/27/2003	77	Yes	No
8	9/9/2003	83	No	No
9	9/9/2003	70	No	No
10	8/11/2003	64	Yes	No
11	8/11/2003	90	No	No
12	8/29/2003	70	Yes	No
13	8/29/2003	83	No	No
14	8/1/2003	58	Yes	No
15	8/1/2003	45	Yes	No
16	8/11/2003	19	No	Yes
17	8/1/2003	45	Yes	No
18	8/6/2003	83	No	No
19	8/6/2003	109	No	No
20	8/11/2003	19	No	Yes

The watershed area for perennial surface water was observed to be less than 100 acres in Greenwood WAU. Of the 20 watercourses observed in the Greenwood Creek WAU perennial surface water in watercourses encompassed watershed areas between 19 and 115 acres with an average of 67 acres. Generally speaking the watercourses that were classified with perennial surface water with low watershed areas were due to springs occurring within or adjacent to the channel that provided surface water flow. Watercourses that were not spring fed and not at their maximum area averaged 86 acres in size.

The next step for the determination for appropriate watershed size for Large Class II watercourse designations will be to determine if stream temperature is affected within Small Class II watercourses following forest harvest. Currently perennial surface water has been observed in watercourses less than 100 acres in the Greenwood WAU. However, the observations of the perennial surface water are at the farthest most upstream observations of surface water. Often, there are stretches of dry watercourse below these designations. Further, the perennial surface water, except when spring fed, is patchy often with only small pockets of water within pools. Therefore, it is unlikely that stream temperature increases would occur if canopy was reduced at many of these locations. However, observations will need to occur over time to determine if this is correct.

LITERATURE CITED

Gumbel, E.J. 1958. Statistics of extremes. Columbia University Press, New York.