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(Draft) Section 4  
**ENGINEERING METHODS**

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## OVERVIEW OF ENGINEERING METHODS

A hydraulic analysis was carried out for Conner Creek. The objectives of this analysis were to determine whether the numerous bridges constructed across the creek in the vicinity of Ocean City were causing any substantial flow constriction and to evaluate the creek of an outlet for local drainage under various creek flow conditions. Drainage problems identified at several specific locations were also examined.

The Study Area lacks any detailed topography. The best topography available for the area is the 7.5-minute USGS Quad sheet titled *Copalis Beach*. This map has a scale of 1 inch equals 2,000 feet and a 20-foot vertical contour interval. To provide any meaningful evaluation, more detailed mapping was required. The County Survey Crew gathered the detailed elevation information needed for the study. The crew surveyed 21 cross-sections of Conner Creek, as well as bridge opening information for the nine bridges crossing the creek. Elevations were tied to the 1988 NAVD system and were taken to the nearest 1/100 foot. For the local drainage analyses, culvert inverts and ditch bottom elevations were shot for selected portions of the Highway 109 drainage system within the Study Area. Nearby ditch and pipe systems and miscellaneous spot elevations were also shot to provide the data needed to complete the analyses. These elevation data are plotted on a series of sheets shown in Appendix C.

Flood level information developed for the 1983 Flood Insurance Study for Grays Harbor County was presented in a different datum: 1929 NGVD. This was converted to the 1988 NAVD datum by adding 3.45 feet to the 1929 NGVD elevations given in the 1983 study. The tide table for 1999 was used to assess the effects of the ocean tides on water levels at various points in the Study Area. The tide table is based upon tide heights at Aberdeen, which is located near the head of Grays Harbor Bay, 20 miles southeast of the Study Area. The error in tidal elevations at the Study Area is minor and is assumed not to impact the conclusions in this

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study. Tidal heights are based upon yet a third datum: Mean Lower Low Water (MLLW). This can be converted to 1988 NAVD by subtracting 2.51 feet from the MLLW tide readings.

### **Conner Creek**

Peak flows for Conner Creek were estimated using flow regression equations developed by the U.S. Geological Survey for Southwestern Washington.

The backwater computation program HEC-RAS, Version 2.2 (HEC, 1998) was used to compute the associated peak stages in Connor Creek for 2-, 10- and 100-year return frequency peak discharge rates. Cross section data to define the Connor Creek channel geometry was collected by the County Survey Group. The cross section interpolation feature in HEC-RAS was used to develop intermediate cross sections for surveyed cross sections greater than 1,000 feet apart. Field survey data was also used to define bridge structures at seven locations. Further information on the HEC-RAS Model can be found in Appendix A.

### **Local Drainage Problems**

A computer model known as WaterWorks was used to develop stormwater runoff estimates for the study sites. This model is commonly used in the Western Washington Area and utilizes the Santa Barbara Urban Hydrograph Hydrologic Method. The model requires as input drainage area, Curve Number and Time of Concentration. The area draining to each of the study sites was delineated using the local USGS Quad map, supplemented with survey data provided by the County and an on-site reconnaissance. A Curve Number simulates the influences of soil type and land/vegetation cover and is used in the model to convert rainfall into surface runoff. Land uses and vegetative cover were obtained from color aerial photos flown of the Study Area in March, 1999, and printed at a scale of 1 inch equal to 440 feet. The soil type for each study site was determined from the Soil Survey for Grays Harbor County, Pacific County and Wahkiakum County (Soil Conservation Service, 1986). The source for the curve numbers was Ecology's Stormwater Management Manual for the Puget Sound Basin (1992)(also known as the Ecology Manual). The Time of Concentration (Tc) represents the time required for runoff to

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flow to the lowest point in the basin and is a function of basin size, shape and slope. Where available, survey information was used to estimate slope. Otherwise, slopes were estimated from the USGS Quad map for the Study Area.

Three study sites were modeled for stormwater runoff (Figure 4-1):

- 1) Silver Maple Resort-Roosevelt Lane, one-half mile south of the center of Ocean City;
- 2) Haven-by-the-Sea; and
- 3) The depressed area adjacent to Johnson's Mercantile.

The latter two are located in Copalis Beach. The models were run for the following standard rainfall events (24-hour period, Type IA Storm):

- 6-month: 2.0 inches
- 2-year: 3.0 inches
- 10-year: 4.0 inches
- 25-year: 4.8 inches
- 100-year: 5.8 inches

Based upon the existing drainage patterns and the size of the drainage area, 3 sub-basins (labeled A, B, and C) were used for the Silver Maple and the Haven-by-the-Sea models while a single sub-basin was used for the Johnson Mercantile Model. Model input and output are shown in Appendix B.

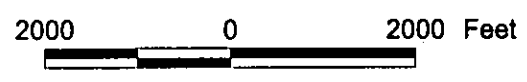
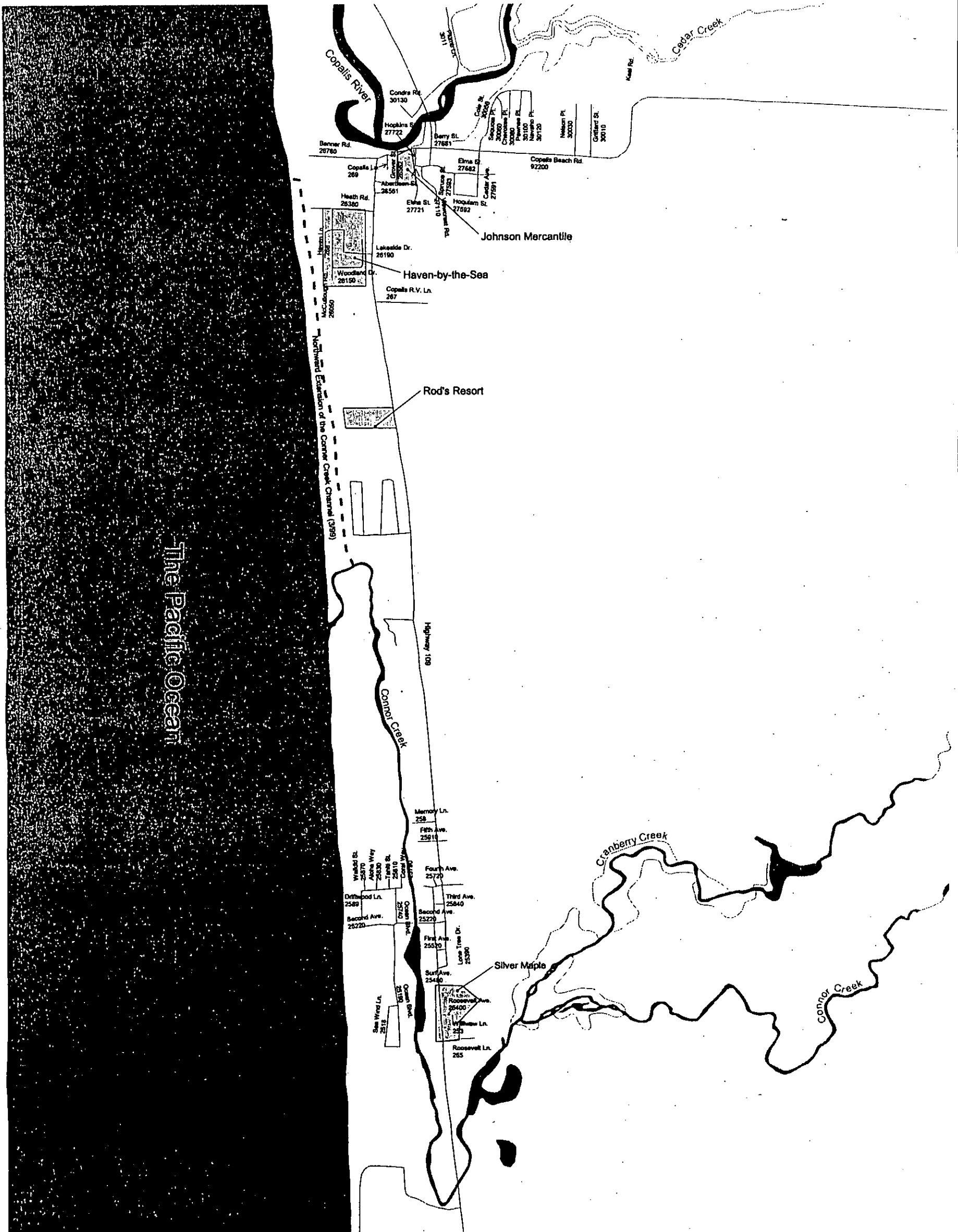


Figure 4-1 Local Drainage Study Sites