complementary way. Exact information on these components is usually not developed until the final design stage.

Where the roadway embankment encroaches significantly in a longitudinal direction into the flood plain, a separate floodplain encroachment study must be made to evaluate the increased flood depths and velocities that may impact, upstream and down stream properties.

Further details defining flood plain encroachment are provided in Section 311.02.02.

D. Other Departments Coordination: Coordination between concerned agencies during the project planning phase will help produce a design that is more satisfactory to all. Substantial cost savings and other benefits frequently can be realized for both the roadway and other development projects through coordinated planning between the various Government Departments and private developers.

311.02.02 Flood Plain Encroachment and Risk Evaluation

When a highway project will encroach on a flood plain, careful consideration must be given to the potential risks from the encroachment. Any proposed project that encroaches on a flood plain either transversely or longitudinally, and is predicted to result in a significant adverse impact on natural flood plain values, a significant increase in flood risk, or a significant change in the potential for interruption of main access roadways, emergency service or major services, must be evaluated with a complete hydraulic analysis and a risk analysis, to be included in a separate flood-plain study or a bridge location and hydraulics study for transverse crossings. These separate reports must document considerations of alternatives which do not include such encroachments. Significant encroachments will not be approved unless there is no practical alternative.

The flood plain study (and/or bridge location and hydraulics study) shall include the following:

A. Hydraulic Analysis: The hydraulic analysis must provide the water surface profile elevations before and after the proposed project in both the upstream and downstream directions for a distance to where it can be shown that no further impact over pre-project conditions is influenced by the project for: (i) the design event storm, (ii) for the 100 year storm, and (iii) the maximum probable storm (usually the 500 year event). Besides the peak water surface profile, the analysis shall include the flow volumes, velocity profiles (velocity at various points in the cross-section), and hydraulic structural alternatives that were evaluated to mitigate significant encroachment.

The frequency with which the highway or watershed divide is likely to be overtopped should be stated. If the overtopping flood is a 500-year flood or greater, it should be stated. The location of the overtopping should be indicated.

B. Economic Analysis: An economic analysis should include a comparison of design alternatives, using expected total costs (construction costs plus risk and damage costs) to determine the alternative with the Least Total Expected Cost (LTEC). The comparison will include probable flood-related costs during the service life of the facility for: highway operation, maintenance, and repair; highway-aggravated flood damage to other property; and additional or interrupted highway travel. Other costs include crop damage, structure damage and public inconvenience.

C. Study of Flooding Encroachments: The flood plain study should include an inspection of the flood plain to determine the increase in the number of flood receptors and the increase in the damage to present flood receptors that will result from the expected increase in flood heights. Consultation with local citizens and other Departments should be initiated where necessary to adequately assess encroachments.

D. Risk Assessment: All designs with flood plain encroachments should include an evaluation of the inherent flood-related risks to the highway facility and to the surrounding property. In the traditional design process, the level of risk is seldom quantified, but is instead implied through the application of predetermined design standards. For example, the design frequency, backwater