listed as high consequence areas in previous risk assessments by the pipeline operator. The scope of
the study was based on the environmental factors from the assessed sites. The sites were namely as
Site A Segamat, Site B Jabor, Site C Sg. Ular, Site D Sg. Chukai and Site E Rangoon. All of the
sites have different environmental factors such as variation in term soil types. The factors to be
considered in the assessment of environmental consequences that represented the selected sites were
material hazard factor, spreading factor, environmental effects and degradation of chemical. All of
these factors were analysed by using the fuzzy based approach to generate the index value for each
site. The details of the environmental factors that are taken into consideration are shown in Fig. 1.

![Environmental Consequences Index Diagram]

Fig. 1. Environmental consequences index (ECI) factors[1].

**Method**

The methods for environmental damage assessment were vague because the available
information was imprecise. However, efforts had been made to assess the damage based on
several assumptions. Fig. 2 below shows the framework for estimating environmental
consequences index (ECI). The basic procedure was developed by Arunraj [5] for a chemical
plant. However, some adjustments had been made to fit in the procedure to gas pipeline
environment in Malaysia specifically so that it reflected each sites condition. The damage area
of the incident was calculated using ALOHA software by considering the details of the site such
as atmospheric and topography condition.

**Damage Area Assessment.** The calculation of damage area was made after the high
consequences area had been identified through site selection study. A software named ALOHA
(Areal Locations of Hazardous Atmospheres) was used to model the damage radii. The procedure
incorporates source strength as well as Gaussian and heavy gas dispersion models and an extensive
chemical property library [8]. Current practice in related industries in Malaysia uses a simple
potential impact radius equation, which uses only pipe pressure and pipe diameter data. The
limitation of this equation is that it does not yield the critical layer that illustrates accident severity.
Table 1 shows the input for ALOHA. Other required data is local condition information such as the
atmospheric conditions of the selected sites. ALOHA generated results of damage radius used in the
analysis as shown in Fig. 3 and were used in the estimation of ECI.

**Sites Evaluation.** After the damage area had been calculated, sites evaluation was made to
identify the related factors to be included in the analysis. The sites evaluation involved assessment
of distance nearby water source, soil type, wind speed, relative humidity, mobility in air and
bioaccumulation. Some data were taken from related government agencies and some other data
were taken on site.