INTRODUCTION

The global increase in the supply and demand of natural gas and oil has resulted in many new proposals for pipeline delivery systems throughout North America, which will result in thousands of new stream crossings if constructed. These pipes will cross a wide spectrum of stream, floodplains, and aquatic ecosystems – from arid, headwater streams, to perennial, mainstem channels – that vary greatly in their response to natural and anthropogenic disturbance. Even without additional new pipelines, the current distribution of pipelines throughout North America is quite extensive (Figure 1), and poses varying levels of risk to ecosystems.
RISK ASSESSMENT

Because of the static nature of pipes and the dynamic nature of many streams, there are inherent risks at many of these crossing locations to aquatic species and habitats. To assess these risks, the US Fish and Wildlife Service in collaboration with the Ruby Pipeline, LLC, have developed a pipeline crossing framework (Figure 2) and linked risk assessment screening matrix (Figure 3) for project applicants and reviewers.

Figure 2 Generic waterbody crossing framework developed by the FWS

The crossing framework provides a robust justification for baseline data collection that is linked to a risk analysis, project design, site restoration, and implementation and effectiveness monitoring. Baseline data include floodplain and stream characteristics, such as valley width, riparian corridor, floodplain dimensions, stream type, stream slope, sinuosity, and bed and bank materials that allow application of the risk screening matrix.
The risk matrix, embedded within the framework, is based on potential stream responsiveness to disturbance utilizing physical characteristics of the stream system. Because the x-axis relates to physical characteristics, reduction of risk generally requires relocation of the stream crossing. The y-axis describes potential impacts due to the degree of disturbance, construction methods, and extent of artificial stabilization, so risk on this axis can be reduced through both design and relocation. Using this geomorphology baseline, combined with the qualitative evaluation of relative risk, potential effects to aquatic habitat and species can be inferred.

**CASE STUDY**

The framework and matrix were tested on the Ruby Pipeline which traverses Wyoming, Utah, Nevada, and Oregon and crosses 1200 water bodies (Figure 4).
The process was highly effective in screening out low risk crossings, which received prescriptive designs and standard Best Management Practices, from higher risk crossings that were individually designed and monitored. This framework and risk matrix approach allows project developers and reviewers to focus resources and monitoring on the crossings that present the highest risks to aquatic habitat and species, while expediting design and construction, and minimizing the monitoring of low risk crossings.

**SUMMARY**

While primarily intended for new pipeline projects, the framework and matrix are also well-suited to the evaluation of existing pipelines to identify crossings that are at a high risk of pipeline exposure and rupture. The framework and risk matrix are easily adaptable to any linear transmission and/or transportation projects, such as power lines and highways.

The approach described in this extended abstract is provided in detail in the following publication: