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INTEGRITY MANAGEMENT: AUTOMATED ANALYSIS FOR CLASS LOCATION

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ABSTRACT

Class location analysis is a key component of an effective integrity management plan. Application of class location results vary based on the product transported, but regardless of product, the analysis has requirements of audit, reporting, and annual update.

Process definition and reengineering as part of the Natural Gas Business Unit (BP Canada) pipeline integrity management system was a driving force behind implementation of an automated class location analysis. The results of the automation effort have been manifested as:

- Reduced data acquisition costs;
- Improved data workflow;
- Increased data reuse;
- Cost savings through personnel reduction, and;
- Consistency in application of rules defined by the pipeline integrity management system.

INTRODUCTION

The class location analysis is a distance sensitive analysis that aims to locate and quantify areas that either pose risk to the pipeline or are risk receptors.

Typically, the class location analysis is carried out using manual mapping techniques; techniques that prove difficult to implement in a consistent manner across pipeline systems several thousand kilometers in length.

TRADITIONAL CLASS LOCATION APPROACH

The traditional approach to class location analysis is labor intensive. The approach typically begins with putting surveyors in the field to collect structure and gathering area setback information.

Unless addressed up-front in the field data collection process, pipeline systems spanning large geographic areas will suffer from inconsistencies in data collection methods and results. While these inconsistencies usually show up as problems in naming conventions and file formats, it still means that additional effort is required to make the class location input data (structures and gathering areas) fit for purpose, that is, consistent enough for performing a class location analysis.

The overall goal of the field data collection is to trigger a class location workflow process like the following:

- Interpret and transpose survey notes and drawings
- Manually draft structures and gathering areas onto pipeline alignment sheets meeting class location criteria
- Move a “sliding mile” along the pipeline depicted on the alignment sheets
- For a structures analysis:
  - Count the number of structures within 200 meters of pipeline
  - Establish class number and extent of class location zone
  - Aggregate overlapping class location boundaries
- For a gathering areas analysis:
  - Find gathering areas within 200 meters of pipeline
  - Establish extent of class location zone based on maximum extent of gathering area within 200 meters of pipeline
  - Extract chainages for inventory and records
- Record results in an unstructured format and continue analysis

The field based data collection is very costly and time consuming, and, as is evidenced in the process outlined above, the rigor applied to data collection accuracy through survey methods is often obliterated through the crude approach to data manipulation in a manual process.

Another important aspect of the process outlined above is the level of repetition that exists in the class location analysis manual process. The obvious repetitive tasks within the process above include posting of structures and gathering areas onto alignment sheets and the subsequent analysis steps related to sliding and counting. For humans, repetition of tasks results in familiarity; but familiarity can introduce a lackadaisical attention to quality and consistency. Again, much of the work in the class location analysis process is repetitive which makes the process (or at least portions of the process) ideal for implementation with a computer based information system capable of map analysis, that is, a geographic information system.

PROCESS REENGINEERING: DATA COLLECTION

In an effort to improve upon the traditional approach to the class location analysis and to optimize the entire workflow, the overall process was split into two distinct parts: 1) data collection and 2) analysis.

The first process modification for data collection was to avoid, wherever possible, field-based data acquisition for structures and gathering areas along the pipeline right-of way. The rationale for taking this approach was to improve the consistency of data collection and to reduce the time and costs associated with fieldwork and land access.

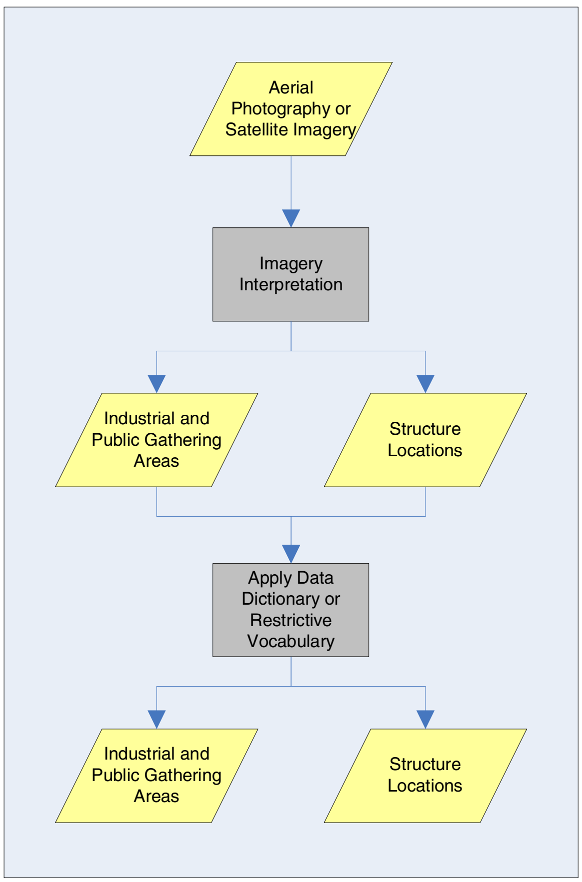

Figure 1 –Imagery Interpretation Process (Simplified)

The alternative of choice to field-based data collection was the use of imagery interpretation or remote sensing techniques (Figure 1). BP Canada's corporate geographic information system was the source for recent aerial photography (digital) and against this source interpretation was performed. In completing the interpretation work, the personnel involved is controlled in terms of number and qualifications. This reduces the opportunity for error and increases the level of consistency in imagery interpretation.

Imagery interpretation results were captured in a geographic information system file format with a predefined attribute structure. This structure facilitated the use of a data dictionary, which in turn enabled the personnel to choose structure and gathering area categories from a restrictive list. The data dictionary itself was based on internal documentation that is part of the BP Canada Pipeline Integrity Management System. Choosing categories (and sub categories) from a controlled list greatly increased the efficiency with which features were collected and enhanced the consistency of feature classification.

The importance of setting up a data dictionary prior to initiating imagery interpretation was one of the critical components of optimizing the data collection process. One immediate benefit was realized in a reduction in time spent to perform quality control checks. Another improvement was realized in a reduction (virtually elimination) of time required to rework data into a consistent categorization scheme.

Was the change worth it? Using image interpretation techniques for data collection greatly reduced the time and costs to collect structures and gathering area information when compared with field-based data collection. In addition, the data dictionary and file format standards enhanced the quality and consistency of the deliverable. Greater consistency in the data deliverables has shortened the data workflow, and development of a robust data dictionary has allowed for use of data in other pipeline integrity and risk related analyses.

PROCESS REENGINEERING: CLASS LOCATION ANALYSIS IMPLEMENTATION

Having the data collection process updated and with the data collection process deliverables defined it was then possible to begin improvement of the analytic portion of the class location process. The fundamental part of this process improvement was movement from alignment sheet based (paper based or manual) analysis methods into computerized techniques implemented within a geographic information system. A geographic information system is the ideal technology choice in this situation because of its inherent capabilities to perform spatial analysis and data management.

When undertaking a process-reengineering task that involves moving manual processes into a computer system the opportunity to change drastically the way in which work is performed will arise. In this case, however, the analysis methodology (Figures 2 and 3) was found to be sound so the improvements were made at the implementation level, that is, the tools used to perform the work were replaced in an effort to reduce the level of tedium and personnel involvement. More specifically, tasks within the analysis process involving proximity calculations, extent derivations, and feature extraction were optimized within the geographic information system.

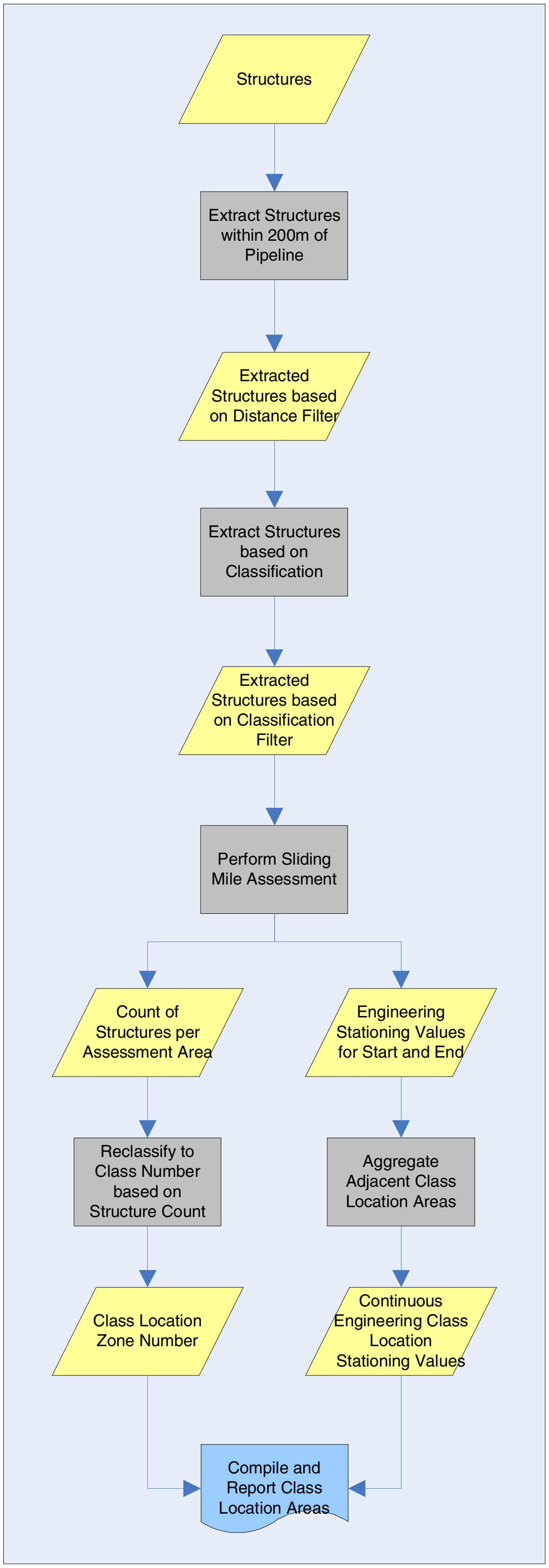

Figure 2 – Structures Analysis

The updated process for running class location within the geographic information system is much the same as outlined for the traditional approach, however, the manner in which the process is implemented has changed drastically. The new process is:

- Import data deliverables into the corporate geographic information system
- Slide a virtual assessment area along the pipeline centerline
- For a structures analysis (Figure 2):
  - Count the number of structures within 200+ meters of pipeline (+positional error)
  - Establish class number and extent of class location zone
  - Dissolve overlapping class location boundaries
- For a gathering areas analysis (Figure 3):
  - Find gathering areas within 200+ meters of pipeline (+positional error)
  - Establish extent of class location zone based on maximum extent of gathering area within 200+ meters of pipeline
  - Extract chainages for inventory and records
- Record results in a structured format and continue analysis

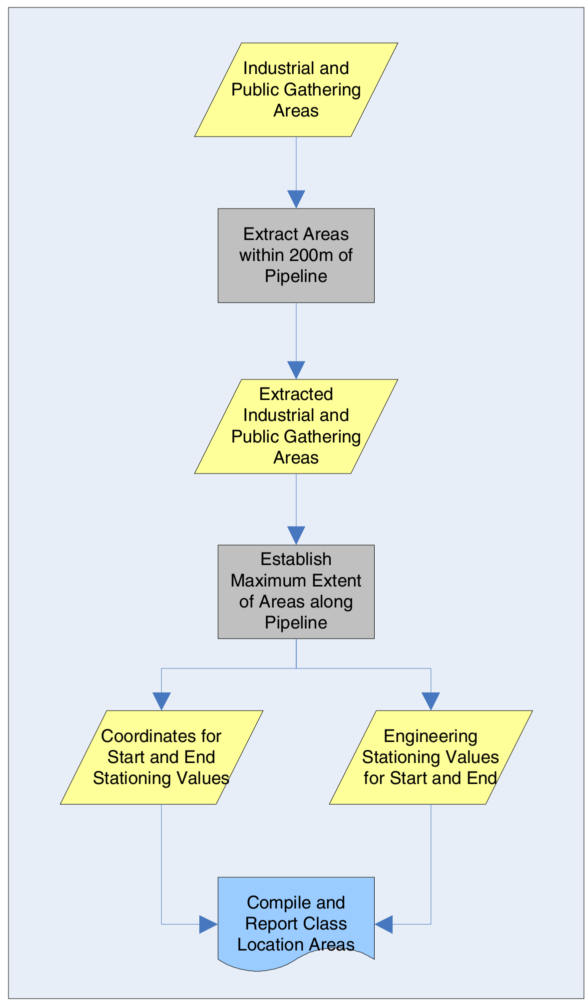

Figure 3 – Gathering Areas Analysis

Using the new approach, what at one point would take weeks to perform was now accomplished within a matter of minutes. The time reduction is attributed to removal of the manual and labor intensive techniques and tools from the process and replacement with geographic information system programming routines (business rules and regulatory guidelines) and consistency in class location rules through programming routines.

Implementation of the new approach had several added benefits such as increasing analysis results reproducibility and introducing the ability to account for location errors. Reproducibility is achievable partly because the automation routines were setup as business rules and are always applied consistently by the geographic information system and partly because the data dictionary enables consistent filtering and extraction of structures and gathering areas.

Location errors are associated with the pipeline centerline, structures, and gathering area outlines and are a normal part of data collection process. These errors affect the analysis because of the 200-meter proximity requirement of the class location analysis.

Accounting for location errors of the pipeline position with respect to the location structures and gathering areas typically results in more conservative class location boundaries. This level of conservatism is justified in the cost savings realized from data collection through remote sensing techniques. In cases where location errors cause an unacceptable level of conservatism a focused field data collection program may be implemented. Completing an analysis that accounts for location errors in manual process would be impractical if not impossible!

ANALYSIS OUTPUT

One of the key benefits of moving the class location analysis into a geographic information system is the capability of integrating the analysis and analysis output with a relational database. In this instance, a database following the Pipeline Open Data Standard (PODS) was modified with an enhanced class location sub-model (Figure 4) to allow for storage of class location analysis results.

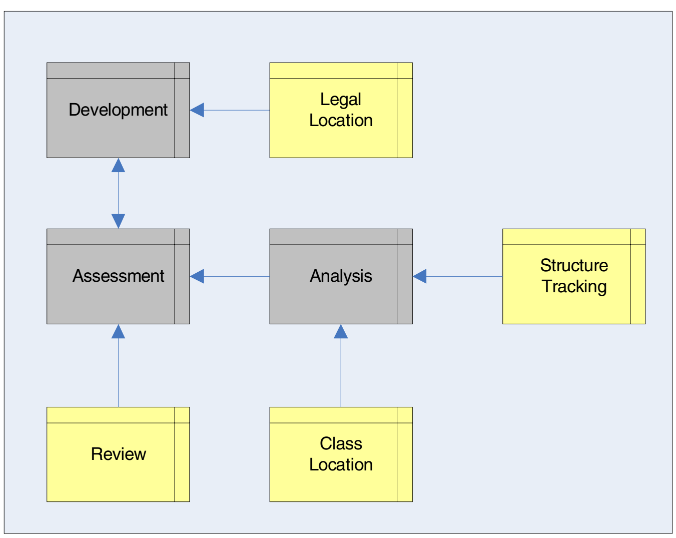

Figure 4 – High-Level Class Location Database Model

After the analysis results are populated into the class location database tables, they are then immediately available for re-use within the geographic information system. In addition, once populated in the database, triggers can be fired to automatically prompt the appropriate personnel to undertake remediation activity for the identified class location zones. Storage of the results in a structured relational database provides the ability for performing audit queries and running reports. These functions were made available through a database front-end application along with additional functionality for managing the results, site visitations, and analysis results validation.

ANNUAL UPDATE

The rigor involved in defining the data dictionary and controlling the image interpretation process has additional benefits that are realized during annual updates. The main benefit is related to change detection, that is, finding locations for new structures or new gathering is a straightforward exercise since this capability is available as a spatial and attribute analysis within the geographic information system. Only areas that have changes in structures or gathering areas need to be reprocessed thus eliminating unnecessary rework.

Another benefit of the automated process is that the business rules are applied consistently. This means that different personnel can run the analysis without cause for concerns in analysis consistency.

SUMMARY

Class location analysis continues to be a critical analysis of BP Canada's Pipeline Integrity Management System. The new process and associated application provides the necessary capabilities to reduce data acquisition costs, improve data workflow, increase data reuse, provide personnel cost savings, and provide consistency in analysis results.

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