BP
Mardi Gras Transportation System (MGTS)
GIS and Integrity Management

2007 GeoGathering Conference

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Introduction

- Overview of BP Mardi Gras Transportation System (MGTS)
- PODS and development of new offshore model
- GIS
  - Progress
  - Challenges building and editing database
  - Underwater inspection data
  - ILI data
  - Generation of automated alignment sheet
  - Internet delivery and reporting
  - Future

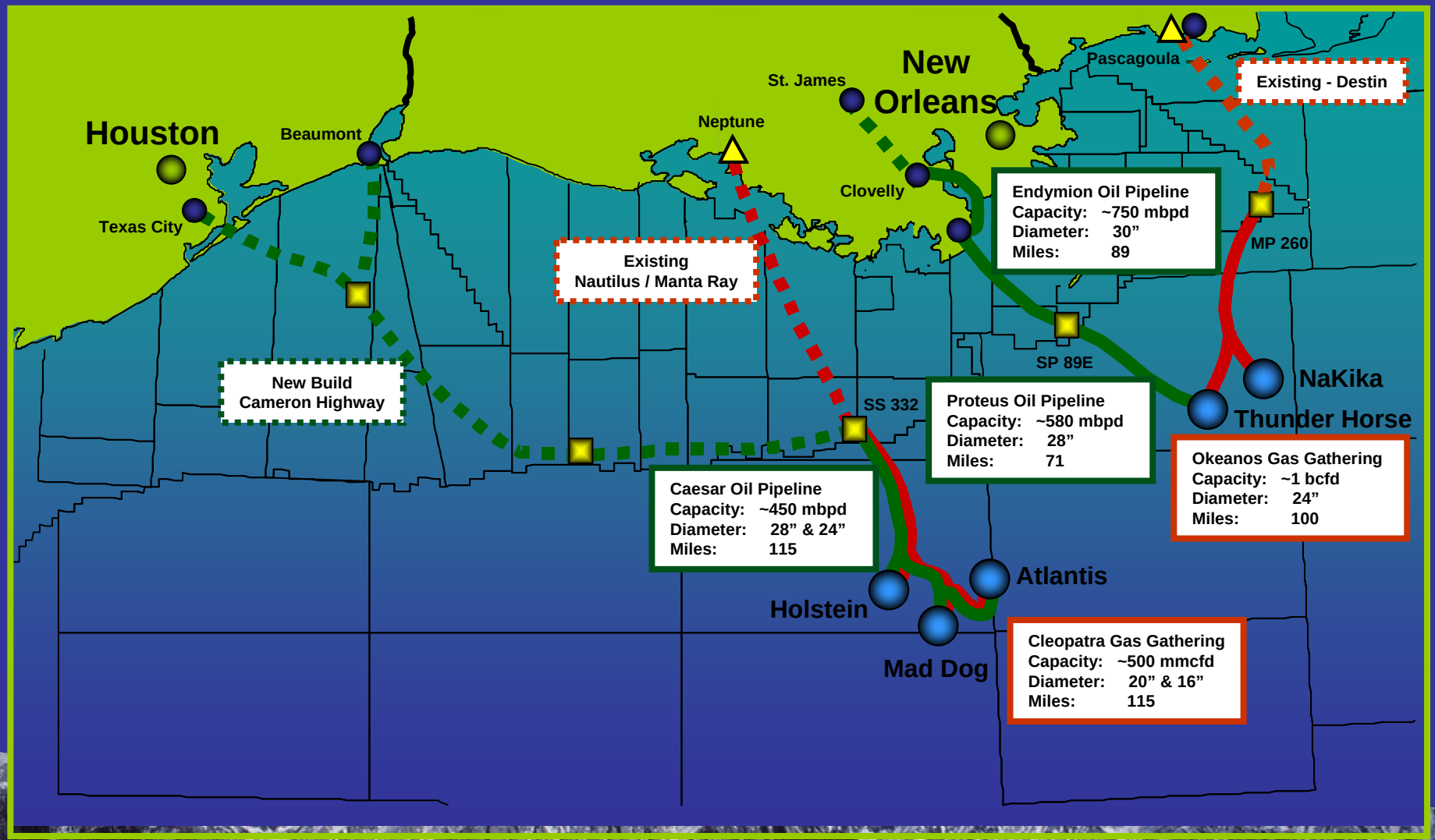
BP Mardi Gras Transportation System

- One of the
  - Most deepest
  - Technically advanced
  - Challenging offshore pipeline projects

ever built

- The largest and most complex deepwater system not only in the Gulf, but also in the world

Mardi Gras System Overview



MGTS Data Management System

- Implemented in Enterprise Geodatabase using Pipeline Open Database Standard (PODS)
- Onshore model already developed (version 3.2)

Offshore Model

- MGTS GIS Team developed comprehensive offshore model
  - New facilities – flexjoints, strakes and fairings
  - Physical Inspection Data – subsea spans, debris, mechanical damage (used to store all inspection data)
- These tables have been mostly accepted by the PODS technical committee
  - Ensure that they are generally applicable to the offshore pipeline industry

Physical Data Model	
Model: Offshore	
Package:	
Diagram: Offshore	
Author: Administrator	Date : 3/27/2006
Version :	

Offshore Data Model

Draft Release 1.0

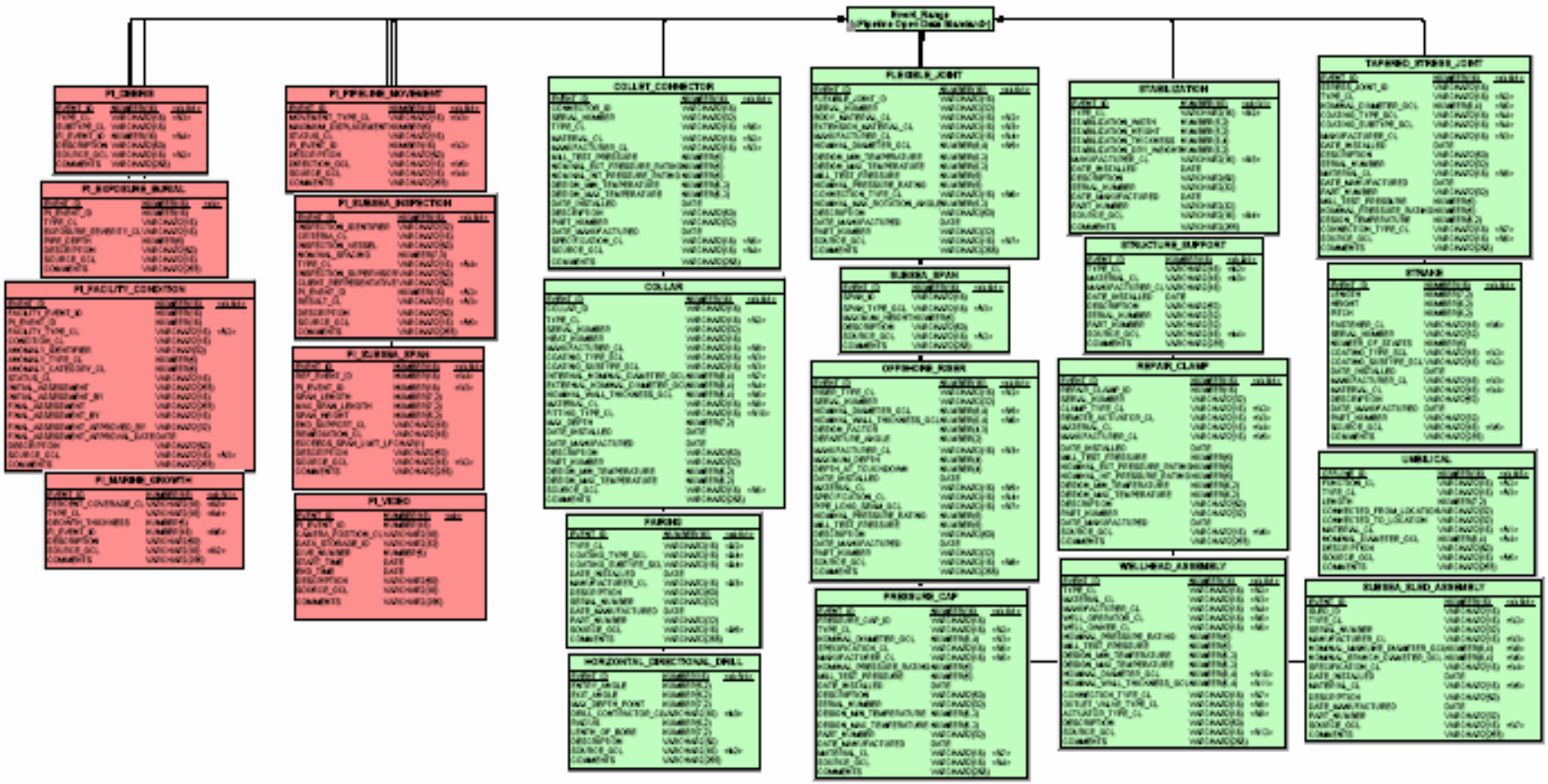
Model is subject to change

Physical Data Model

March 28th, 2006

Physical Inspections

Pipeline Facilities



GIS Progress

- GIS and data management is nearing completion
- Once completed will provide a level of access to pipeline design, environmental and integrity data that will set the standard in the offshore pipeline industry

Building and Editing Database

Basis Starting Point

- Good three dimensional center-line (3D) – consistent with Barge tallies
- From this all other data can be linearly referenced along the pipeline
- Major Challenge
  - Three main installation Contractors
  - Using four vessel/ spreads in numerous campaigns
  - Each contractor reported back in their own customary formats

Initial Set Up

- Convert all coordinates values to NAD 27 datum geographic coordinate in US survey ft
- Slack pipeline centerline station values or linear reference control points established at buckle arrestors, collars, anodes or where suitable X, Y, Z values existed. Stationing was calculated using co-ordinates provided at time of pipe lay
- Station Values set to 0+00 at flexjoint and run to designated end of pipeline
- Remainder of geometry was created from coordinates of pipe joints (welds) and pipe lengths (joints) and other physical features

Initial Set Up

- All pipeline and fabricated assemblies
- Galvanic anodes, crossings, bends and main line valves calculated using X, Y and Z coordinates
- As built anomalies debris, spans
- Horizontal drill sections
- Mile posts calculated and added as sheet note
- Fairing and strake data station values were calculated and loaded
- End of process thorough Quality Process was carried out

Integration with other systems

- Digital Video
- Documentum
- ILI
- Hurricane Response

Assigned Risk Categories

- Resultant inspection data is reviewed and risks are assessed and assigned three main categories
- This will ensure the pipeline Integrity is managed and maintained
- Control measures include time stamped activities such as Visual Inspection, CP measurements, product compositional monitoring, testing and maintaining safety systems

Green	Superficial
Amber	Assessable
Red	Critical

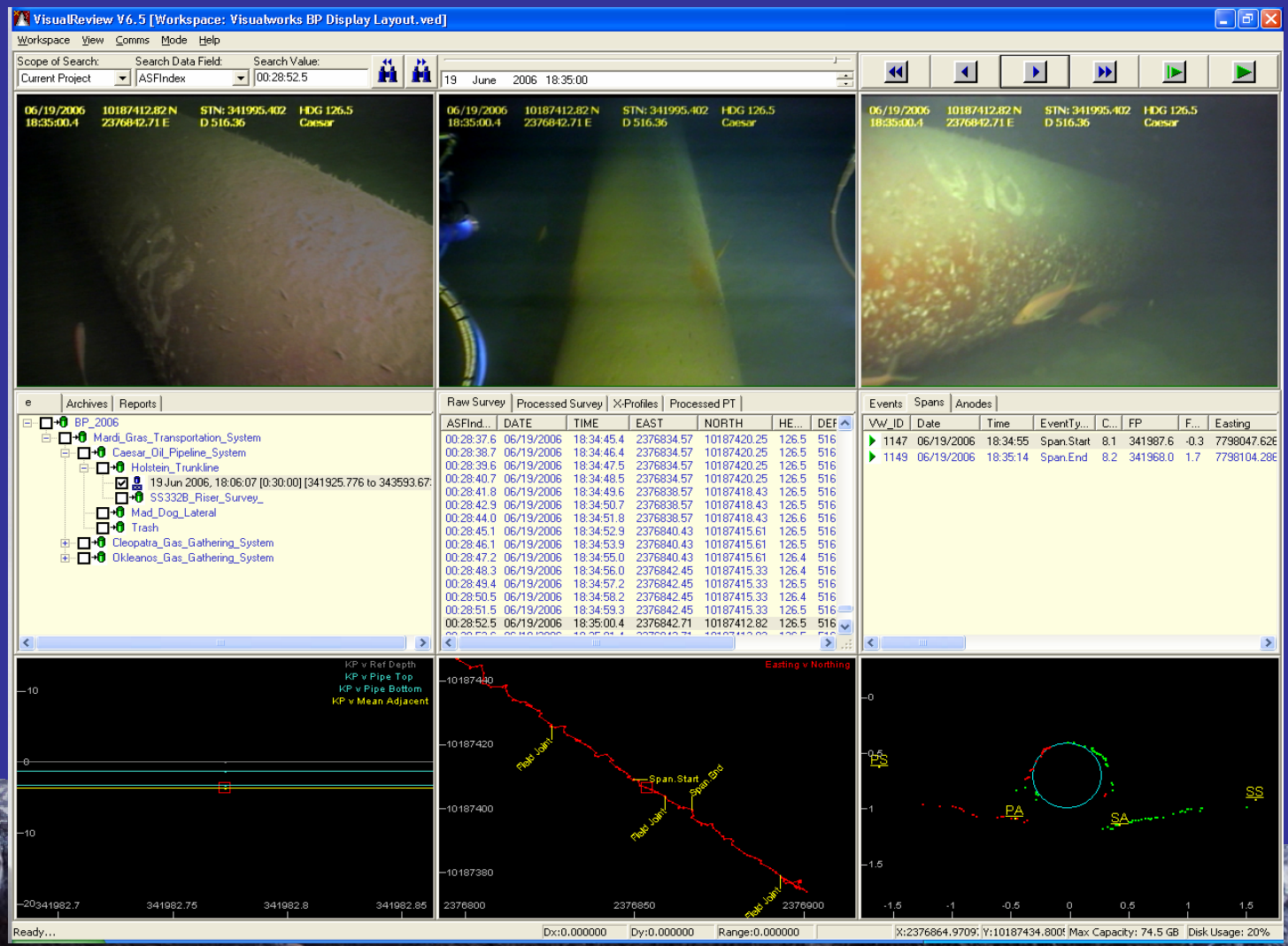
Underwater Inspections

Decided to store all sub sea inspection data in newly developed physical inspection tables in GIS

- Subsea Pipelines are regularly inspected as part of BP's Integrity Management program
- Objective of inspections is to check for stability, damage, debris and that the pipeline is free from, and adequately protected against external corrosion
- Working class ROV is typically used for this type of inspection

ROV Inspections: Summer 2006 campaign

ROV inspections: Visual GIS



Features

- Integrates With VisualWorks Digital Video
- Select Data By:-
  - Map Click
  - KP
  - Geo Position
  - Events Listing
  - Survey Project
- Year on Year Pipe Comparison
- Hyperlink to Geo Database

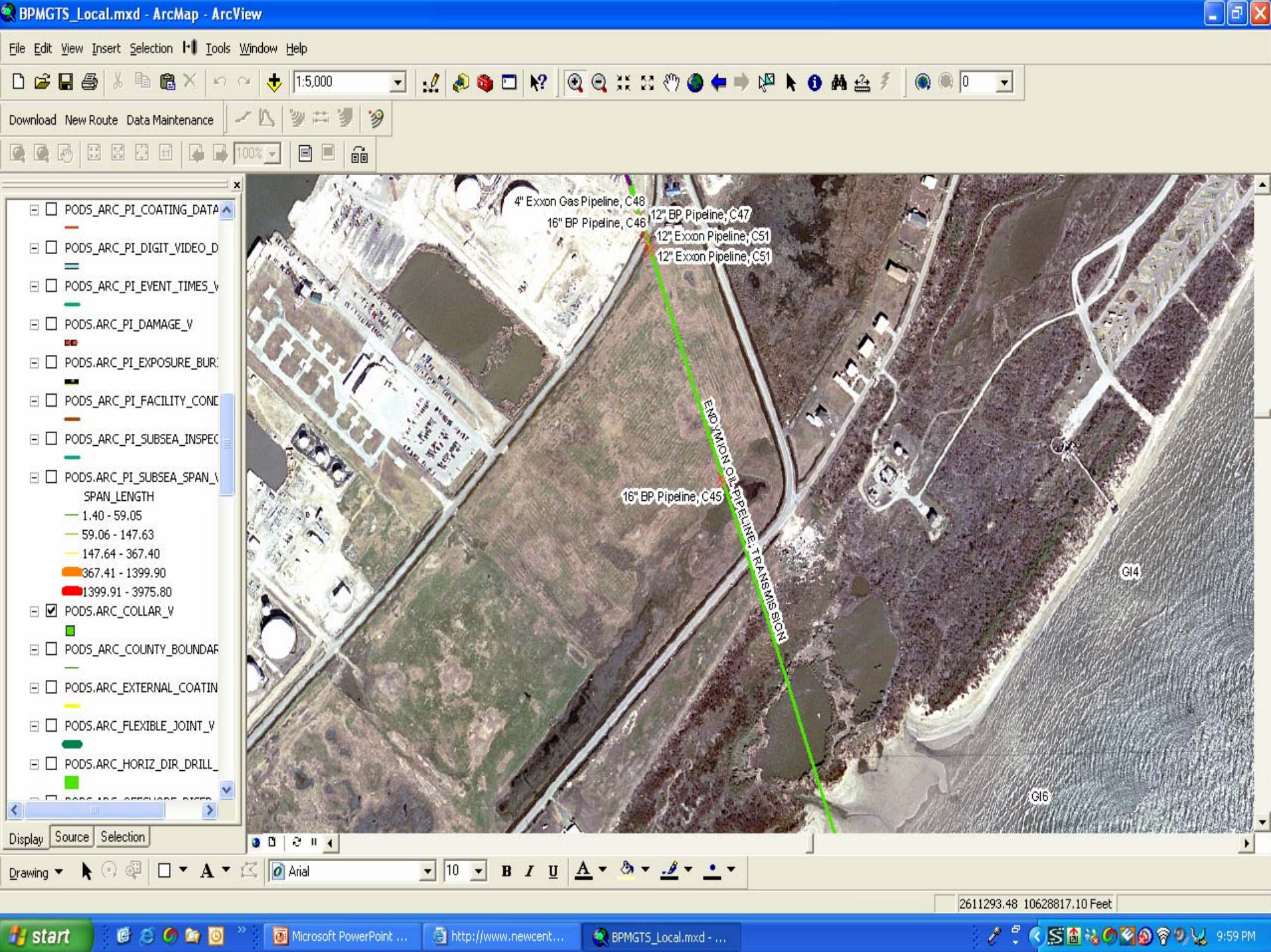
Subsea Pipeline External Inspection Specification

BP Developed document which

- Defines Technologies require to inspect pipelines
- Ensures that the resulting data is reported in a consistent manner that can be loaded into GIS
- Present challenges to sub sea survey industry in Gulf of Mexico
- Each contractor typically works to in-house standards and reporting formats
- Pay dividends allows BP to extract maximum long term value from costly subsea inspection works
- First survey completed July 2006, using above process

Example 1
Raster Imagery

- During the project several raster imagery data sets were used for illustrative and interpretive purposes
- Endymion onshore pipeline
- Flown prior to construction
- Again post construction
- Area was devastated by Hurricane Katrina
- To assist in assessment of damage
- Line was re-flown in January 2006
- Images showed how great the surrounding land and buildings were affected
- New sheets were run with 2006 images and compared with the older post construction images and the GIS was updated to allow team to compare pre and post Katrina images on line through internet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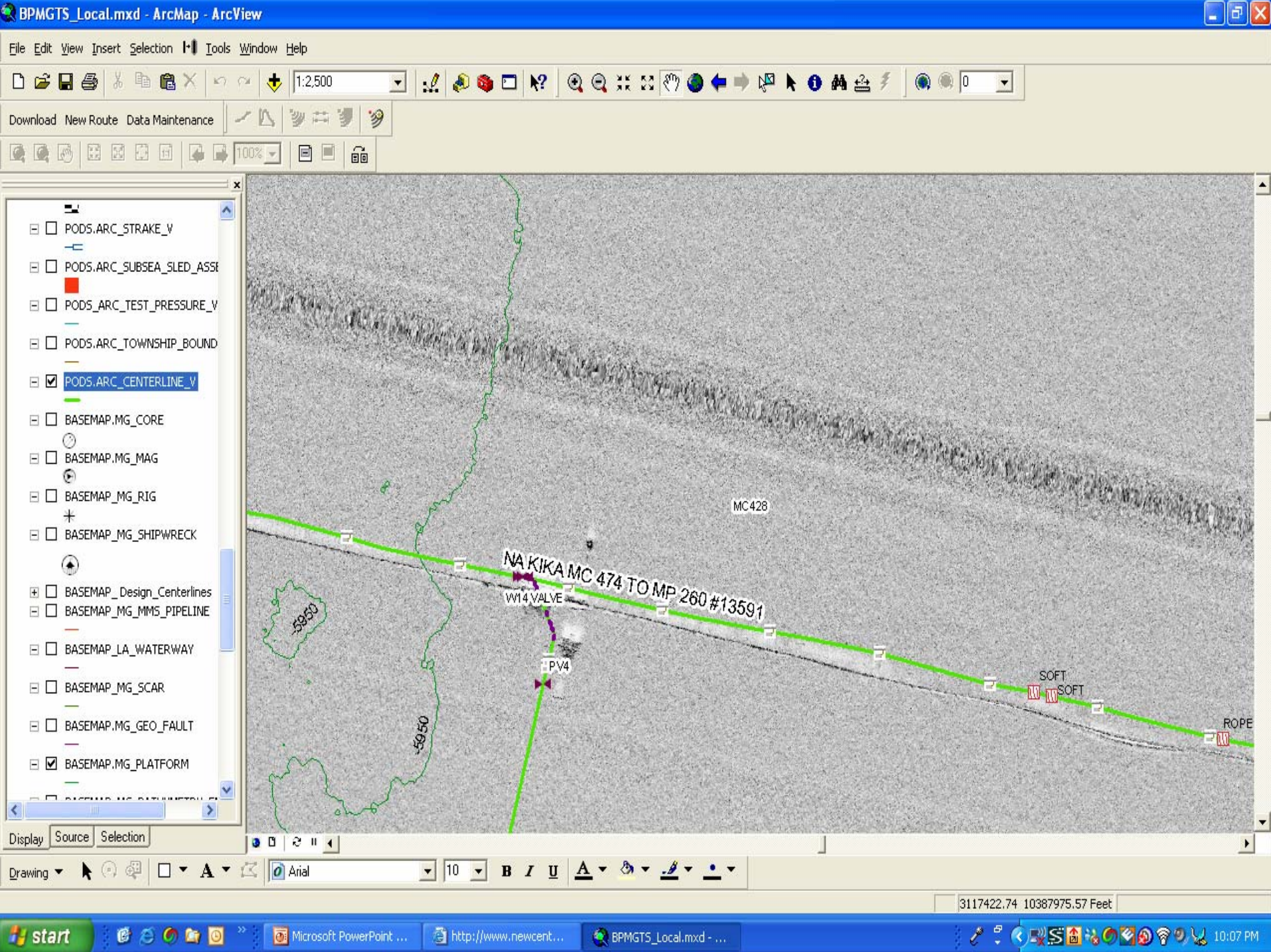
Example 2
Side Scan Sonar

- Side scan sonar (SSS) was used to distinguish where underwater crossings had occurred along the pipeline
- Data is displayed in the PODS Browser Intranet map tool
- Allows further quality assurance of the data received from as-built lay vessels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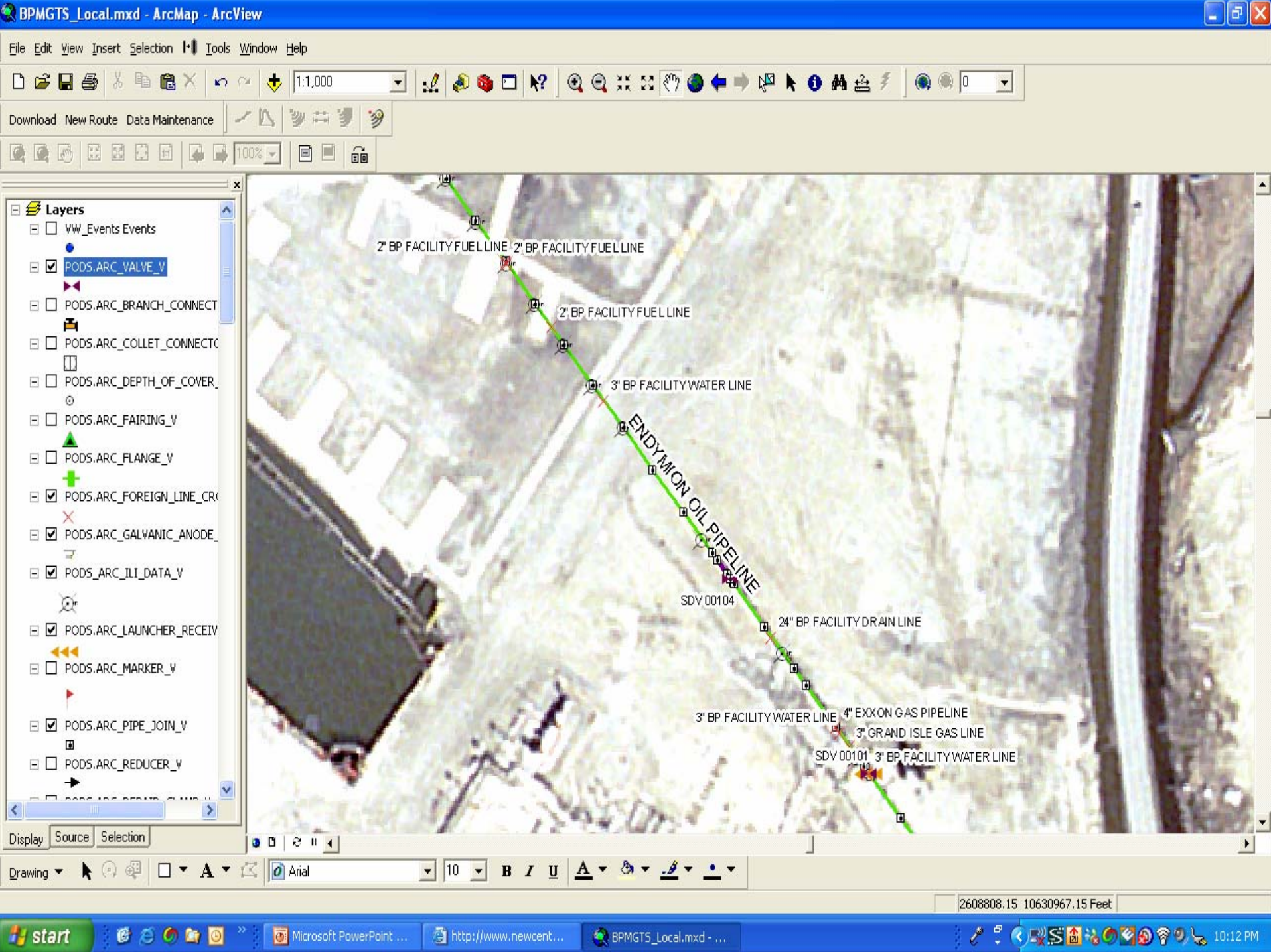
In-Line Inspection (ILI) Correlation

- ILI data originating from various vendors was correlated with the PODs database using program called iAlign
- iAlign tool uses the data in PODS as the bench mark and aligns the linear reference or station values from the pig to the values stored in PODS
- Operator simply maps the different columns of data from the ILI vendors to the ILIX PODS Subsea model and loads correlated data directly into PODS
- This allows for additional correlation and graphic output in the form of integrity alignment sheets
- The anomalies and features are categorized using the Anomaly Library for Inspection Assurance Standards (ALIAS)

Example 3
In-Line Inspection (ILI) Correlation

- ILI tool run on onshore portion of Endymion pipeline
- Run produced excellent alignment sheets
- Each weld on line had previously been loaded into PODS database
- Welds where pups could be identified were used to control the linear reference of the ILI data
- By using iAlign tool , team was able to verify the integrity of the 3D linear referencing on the pipeline and assign as built station values to anomalies found
- All ILI data including anomalies and pressure ratios were then loaded into PODS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ENDYMION OIL PIPELINE
SDV 00104
24" BP FACILITY DRAIN LINE
3" BP FACILITY WATER LINE
4" EXXON GAS PIPELINE
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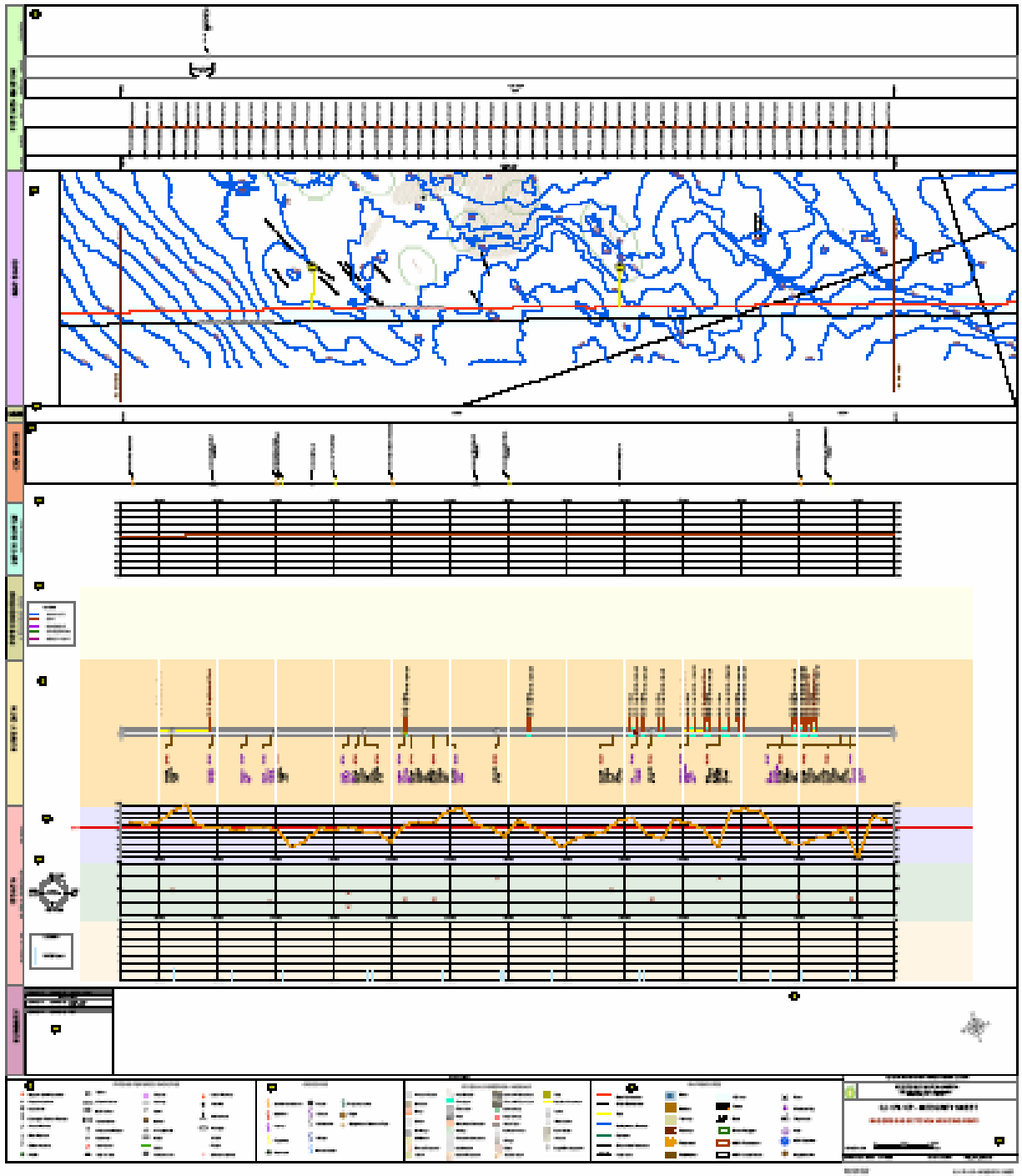
Automated Alignment Sheet Generation

- As built and Integrity management alignment sheets were generated using automated mapping and sheet generation technology
- Created a ILI / PI / CP alignment sheet – using program called Template Designer

Divisions included and Integrated into template

- Map Layers - graphically displayed geo-physical, centerline, bathymetry, MMS block numbers, product flow, etc
- Depth profile – Line graph depicting Gulf of Mexico bathymetry (ft)
- Pipeline Features/ Facilities - displays point and linear references ie valves, WSA's, crossings
- Pipe Material – Grade, diameter, wall thickness
- Pipeline condition – percentage of total measure of pipeline, spans, exposure, movement, stabilization
- Survey data –
- ILI data – displays orientation band and wall thickness loss, interior and external defects
- Title - line, name, scale, date
- Revisions/ References –
- Legend – facilities and physical reference features

Acrobat Document



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GIS Internet Delivery and Reporting

- Huge Investment bringing data together in the PODS database and keeping up to date
- Logical next step make the data accessible to team members wherever their location
- PODS browser is internet tool that allows users to view and analyze pipeline data using ESRI ArcIMS technology
- Data is displayed on web page in an interactive map

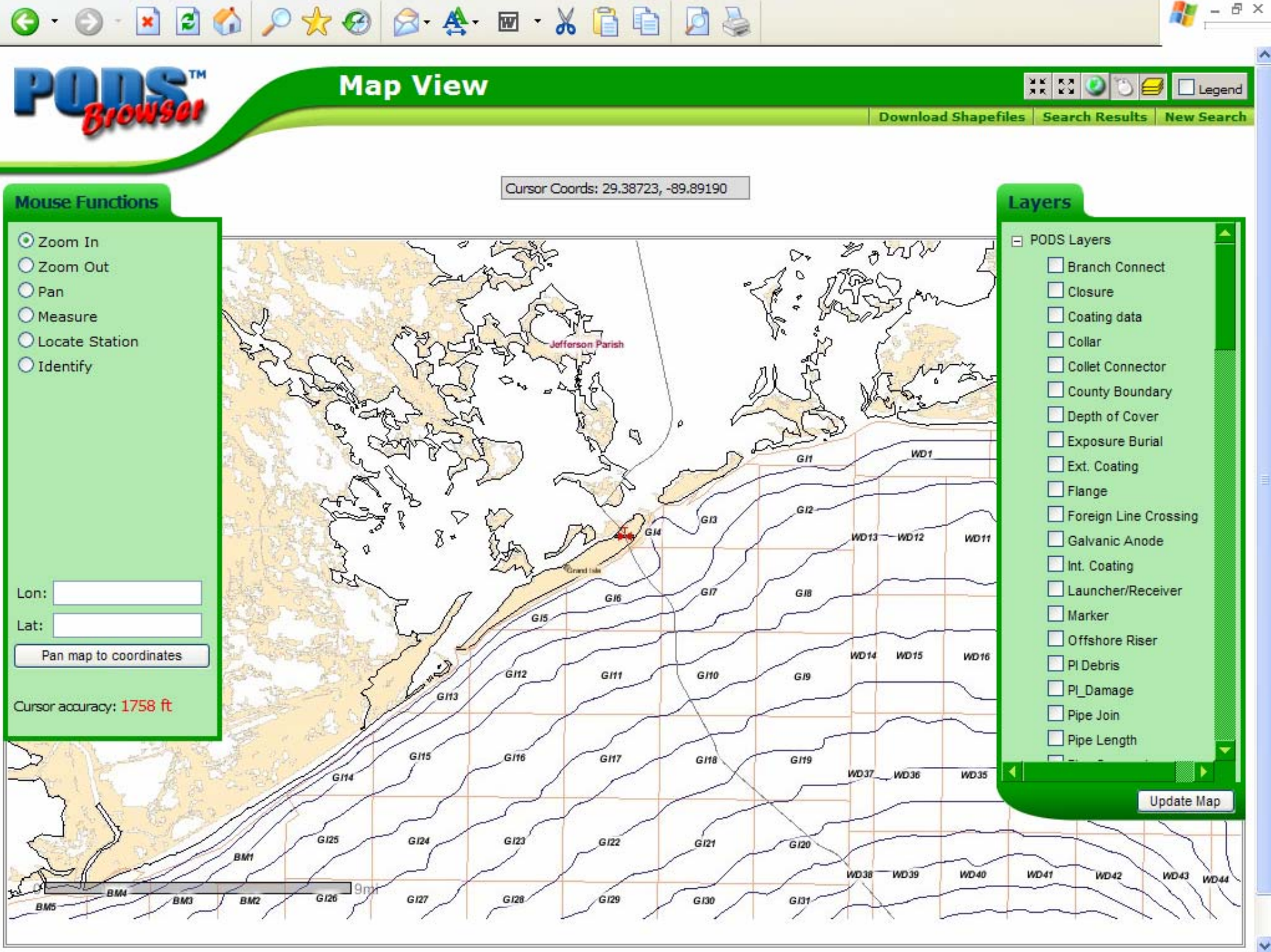
GIS Internet Delivery and Reporting

- User can navigate the full range of the MGTS selecting features to display and zooming in and out
- Base map, side scan sonar, aerial photography can also be layered underneath the facility data to provide the necessary context required during analysis
- This is done with a hot link to BP's corporate engineering document management system
- Through a few simple point and click interface, the user can query the attributes of any feature on the map
- OR a data window can be requested showing the attributes of all instances of a specific feature type currently displayed in the map view

GIS Internet Delivery and Reporting

Underlying base map data for the Mardi Gras system is stored in an SDE instance Map data was including classes were obtained and built from sources:

- MMS – blocks, faults, oyster beds, archeological sites
- USGS – on shore political boundaries, roads, rails, cultural
- Aerial Photography (land portion only)
- Bathymetric surveys, contours, 3d renderings
- Shipping channels
- Side Scan Sonar
- Mardi Gras Design, Construction and Installation Contractors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Identify
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Lat:
Pan map to coordinates
Cursor accuracy: 1758 ft
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PODS Layers
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Closure
Coating data
Collar
Collet Connector
County Boundary
Depth of Cover
Exposure Burial
Ext. Coating
Flange
Foreign Line Crossing
Galvanic Anode
Int. Coating
Launcher/Receiver
Marker
Offshore Riser
PI Debris
PI_Damage
Pipe Join
Pipe Length
Update Map
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GIS Future - Integrity

- GIS operated/referenced in 5 dimensions
  - X, Y, Z, Chainage, Time
- Future integrity plans will facilitate easy generation of inspection work orders and allow fitness for purpose assessments
- Inspection results will be stored in PODs and continually compared to previous inspections for anomaly tracking and trending analysis
- This will allow for graphical and pipeline integrity reporting of each subsequent inspection over time
- Risk Modeling from GIS will allow BP to develop integrity management plans to ensure pipeline is operated continuously in safe and responsible manner

- ***Ongoing project***

Vision

- As part of the Integrity Management Program, Inspection and Maintenance data will be captured and stored electronically in the GIS to maximize the benefits of all ongoing assessment activities and ensure the pipelines ***remain fit for service*** throughout their design lives.


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